THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

NUMBER XXI. SECOND SERIES. Feb. 1, 1804.

Specification of the Patent granted to STEPHEN HOOPER, *of Walworth, in the Parish of Saint Mary, Newington, in the County of Surrey, Gentleman; for certain Machines or Machinery, upon improved Principles, and Methods of using the same, for the Purpose of cleansing of dry and other Harbours, Rivers, Creeks, Bars of Harbours, and preventing Bars from making, reducing Banks or Shoals, opening a Channel through Sands at Sea, or clearing away the Sand or Beach to get off Ships grounded by Accident or Stress of Weather on Sands, and for other Purposes.* Dated February 3, 1803.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Stephen Hooper do hereby declare that my said invention is described by the above drawings, and the following explanation thereof; that is to say: Fig. 1 (Pl. VII), the apparatus for the back water and the reservoir, which may be erected either in a concave form, or any other which local

local circumstances may require, in any place where the waves of the sea come up to the harbour's mouth or near to it, as at the letter A. It may be built of any dimensions with timber or other materials; but the larger the reservoir the greater will be the force of the back water, and the proportion should be about thirty feet in length to twenty in breadth. If built of timber, a number of square piles B must be placed at about two feet asunder. and of such a length as, when driven sufficiently deep, to leave the upper part of them on a level with the top of the pier-head. A row of these piles being placed in front, another row must be driven close to the pier-head to answer to it, and a range to form each end. The front and back rows must be strongly fixed or locked together by timber C, framed across and keyed, and the piles at the ends in like manner; for the whole must be sufficiently strong to confine the body of water contained in it; and to withstand the action of the sea against it, the front part of the reservoir, and the end next the sea, must be supplied with a number of blocks or pieces of timber D, about twelve inches square, framed between the piles from the bottom to the top, to be flush or square with the inside of the piles, for valves to shut against; these blocks must be placed about one foot asunder, and thus openings will be formed between the piles of about two feet wide, by one foot deep. The whole of the front and the end next the sea must be formed with these openings, to each of which a flap, or valve E, must be so fixed, that it may open inwards, and freely admit the water, when the waves drive against the reservoir; and then, by closing when the wave draws back, prevent the water from returning. Thus a large quantity of water will be continually collecting. The bottom of this reservoir must be covered with stones or boards to prevent the

water

water passing through; the back part of it and the side next the harbour must be strongly planked within the piles to confine the water, that part only excepted which communicates with the tunnel. For at the lower part of the reservoir, on the side next the harbour, a sufficient opening must be left to admit the mouth of a tunnel, or tube FF of proper dimensions and length to convey the water from the reservoir to the upper part of the harbour. This tunnel or tube FF must be fixed along by the inside of the pier-head close to the ground, and filled with a number of sluices GG, about ten feet distant from each other. In cleansing a dry harbour, the person employed to superintend the business must at high water open the sluice next above the water's edge; and when the sea runs high, the next below it (for the water in the tunnel will, by the action of the waves on the reservoir, be considerably higher than the tide itself, or level of the water in the harbour; and the current from the sluice or sluices will drive the soil it meets with into the water); and as the tide ebbs he must open another sluice, and then another, during the whole ebb or while the water will flow from them, which it will do at all times when the waves beat against the reservoir; this process will scour, from each part of the harbour along the head in succession, a quantity of soil proportioned to the height of the tide, and of the water driven into the reservoir.

Fig. 2. Horizontal windmill. A, the oak part of the mill which may be built upon an octagon square or any other form, from twenty feet diameter more or less, by fourteen feet deep more or less, with posts B, to be braced or otherwise secured; the outside to open and shut like Venetian blinds, DD, or with a number of valves, or with shutters, or otherwise, either on an horizontal or perpendicular direction, to admit the wind coming into the

 building

building on the weather side, and to fall down or shut to prevent the wind going out on the leeward side on the top of the building. At E, must be a bay or circle for a fly wind wheel F G, to work between in a horizontal direction; this fly wheel F G, is fixed upon an upright shaft; the inside part of this wheel next the shaft at G, must be boarded close, about seven feet and a half from the centre, to form a rim fifteen feet diameter, more or less, to fasten thirty floats or flyers upon, more or less, of a length to work as close to the bay or circle at E, as possible, each float two feet and a half broad, more or less, fixed upon an angle of about ten degrees, more or less. This mill may be built on any suitable building to carry forward any kind of manufactory.

Fig. 3, is a machine for pecking up rocks under water, so as to open or assist in making a navigation, A A, two views of a lighter or vessel, B B B B, are peckers prepared for pecking of stone fixed at the end of iron bars or spars C C C C, of a sufficient length to reach the pecks the vessel is riding over, the upper end of the bars or spars to have a number of notches to hook upon catches as are fixed on the side of the vessel, these peckers are worked by the rolling of the vessel; when the side is down the notch on the spar or bar hooks to the catch at *a*, on the side of the vessel, and when that side rolls up the lower part of the spar or bar, presses against the ship's side at *d*, frees the catch at *a*, and the pecker falls down with velocity to peck up the stone at the bottom. Each bar or spar must have a guide at *e*, to steady the upper end with a roller at the back part, to let the spar slip up and down, by which there must be a weight hanging on a pulley fixed on the centre of the vessel communicating to the roller, to draw the upper end of the spar or bar to the vessel's side on her rolling down,

and

and to admit of its freeing the catch on her rolling up. *f* the weight, *g* the pully, *h* the roller. These peckers may be fixed by different machinery, to work by the motion of the vessel. Where the vessel has no motion, the peckers may be worked by the roller D, working round this roller, extending fore and aft on each side of the vessel as far as the peckers extend, with a number of cogs about three parts round the roller, for a set of cogs fixed to each spar or bar to work into. On the rollers going round, the bar is raised up till it comes to that part of the roller where there are no cogs, when it frees itself and drops down with velocity to peck the stone. These rollers may be put in motion by manual labour, horse, wind, or water, and may be worked by different machinery.

Fig. 4, a shifting keel to assist ships, hoys, barges, or other vessels in going to windward. A A A represents the bottom, side, and end of a barge. The keel forty feet long, more or less, in three pieces or lengths B B B, more or less, two feet deep by three inches thick, more or less, to fasten together at the ends by hooks and rings, or otherwise, which form a joint convenient for putting together or taking to pieces. On the upper and lower edges of the keel at each joint, and in the middle part of the after length, and the fore part of the foremast length are chains fixed, as at *a*, *b*, *c*, *d*, to confine the keel to the bottom of the vessel in a perpendicular direction, and to keep the middle part of the after length in the centre of the bottom at *a*, the chains to be confined as tight as possible. The other three pair of chains, *b c d*, when going to windward, a portion of each chain must be veered away from the lee side to keep the keel straight one part with the other, about four degrees from a line with the main keel or middle line, fore and aft with the

vessel

vessel as *per* the figure; the keel being in this position will draw the vessel to windward when going through the water; observe when the chains to leeward are veered away to take in those to windward, and when put about, to veer away the other chains to shift the keel on the opposite angle, but on making short tacks the keel may be kept centering fore and aft, by taking in on each side an equal quantity of the chains; if the vessel will not stay with a common helm, by veering away the chain *d*, till the foremost length of the keel is about four degrees more across, will assist in bringing her about. When the water is too shallow for the keel, by slackening the lower chain on one side, and taking in those on the opposite side will trace the keel to lay flat to the bottom of the vessel, or it may be taken on board; this keel may be made all in one piece, made fast by joints, hooks, or otherwise, to the side or bottom of the main keel, to admit of its hanging up and down, and kept in that position by chains, ropes, or otherwise, to admit of its being traced up to the vessel's bottom, or her taking the ground or coming into shallow water.

Fig. 5, two views of a lighter or vessel for scouring away bars, &c. A A, lighter or vessel forty feet long, more or less, by sixteen feet broad, more or less, with three wells at the bottom, B C D, one on each side and one in the centre, the bottoms to be level with each other from side to side of the vessel, the middle well C, to be ten feet square, more or less, the sides straight up about three feet, more or less, and then to contract to about eight feet at the top, more or less, and may be built up of a height level with the deck; the two side wells B and D, twenty-eight feet long, more or less, the sides next the well C, may be continued upright about three feet, and then a deck laid across to make the upper

part

part light, the ends, forward and aft, to be built up square with the top of these side wells, the whole to be made water-tight. To let the water into the outer wells B and E, must be six holes, more or less, E E E E E E, cut through each side of the vessel's bottom, each hole to be about twelve inches square, the lower part level with the bottom of the well, the foremast and aftermast of these holes to be kept as near to the ends as convenient, and the others divided at nearly equal distances, to have a valve on the inside of each hole to admit of the water flowing into the well, on the side rolling down, and closing on the vessel's raising up, to prevent the water returning out again; the wells B and D, communicating with the well C, by four holes F, through that part adjoining the side wells B D, with valves on the inside of the wells C, to admit of the water discharging from the outside wells into well C, and prevent its returning, by which means a body of water will be raised in well C, above the level of the water without side the vessel, in proportion to the rolling of the vessel by the agitation of the sea or by other means. The water may be raised likewise by the vessel's pitching; when the water flows in the fore part of the side wells B and D, and when raising up, there being a middle partition in the side wells at G, the water will discharge itself into the middle well at F, the same in the after part of the vessel when falling, and raising the head of the water in well C, is conveyed into a trunk or small well H, about two feet square, communicating with a hole cut through the vessel's bottom, as near the centre as convenient to admit of a tunnel I, to convey the water through to reach down to the ground to scour away all the soil, &c. This tunnel may be made of canvas or other fit materials of different lengths to lace, or other-

otherwise fasten together, to lengthen or shorten as the depth of water may require.

Fig. 6, improvements upon a water-wheel for raising water secured by patent, bearing date the tenth day of November, one thousand eight hundred and one, as described in my specification. A, a square case or cylinder made water-tight seven feet wide, more or less, by thirteen feet long or high, more or less; B B B, the bays or reams for the wheels to work between; C C C, the wheels for raising the water with four floats, more or less, fixed on one shaft F; D D D, a floor or partition under each wheel, made to hold water with eight holes E E E, more or less, of a sufficient size to admit of the water coming through each hole to have valves E E E, fixed with hinges or otherwise on one side, the other side permitted to open about seven inches, which will cause the water that comes through to flow in a circular direction, contrary or opposite to that which the wheel works upon, which will assist the raising of the water. These partitions and bays for the wheels to work in must be kept about three feet asunder, or as far as one wheel will raise the water up for the other to take hold of it; and by increasing the number of water wheels, &c. the water may be raised to any height, and the pace or velocity for the wheels to work to raise the water, will be about sixty revolutions per minute.

Fig. 7, A, a water-wheel fixed upon an horizontal direction, 12 feet diameter, from the outer part of the floats, more or less; B B B, 16 floats, more or less, 2 feet long by 2 feet broad, more or less, fixed on an angle of ten degrees, more or less, on the outer rim of the wheel at A, eight feet diameter covered with boards close home to the shaft, to prevent the water passing through. This

wheel

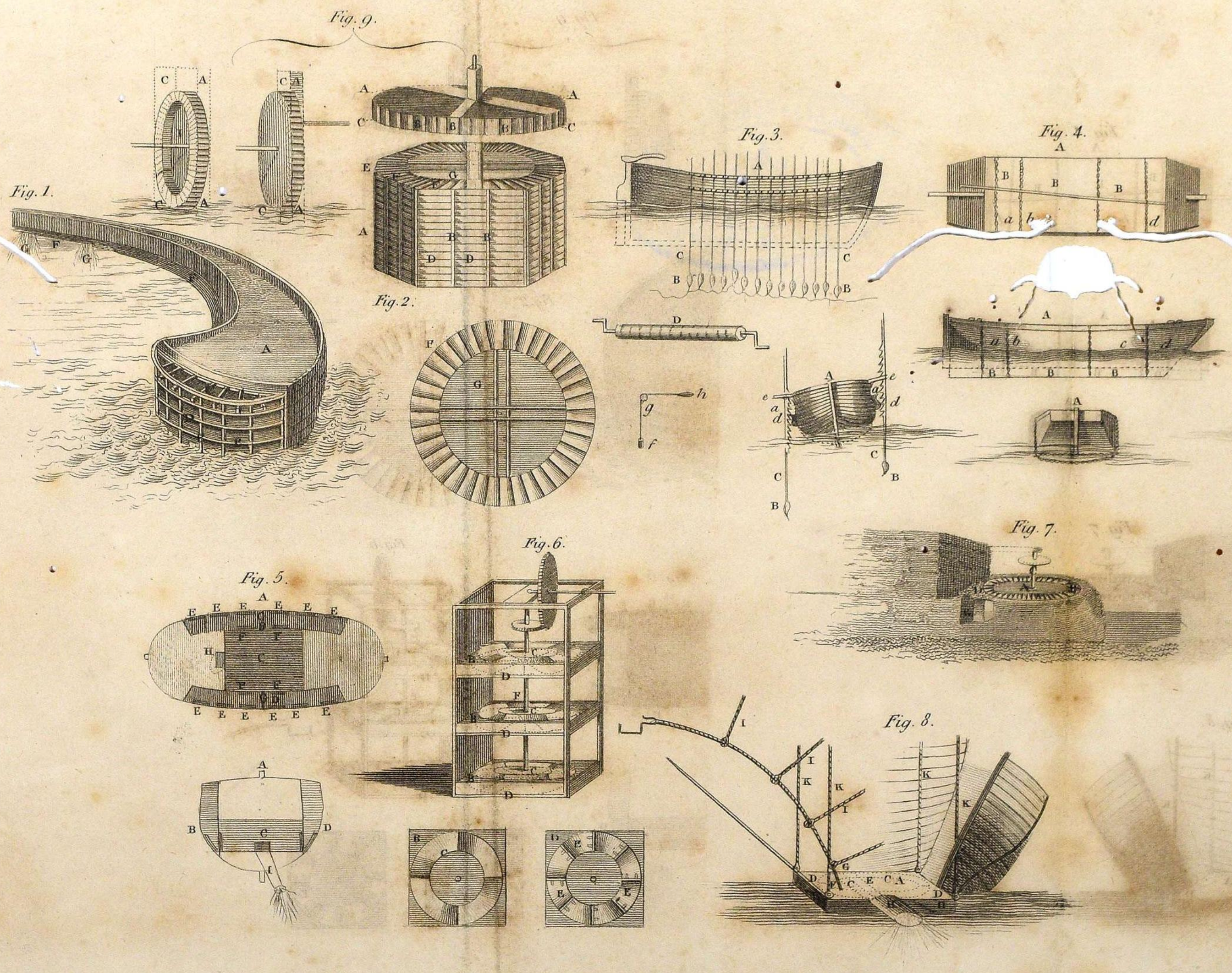
Fig. 9.
Fig. 3.
Fig. 4.
Fig. 1.
Fig. 2.
Fig. 7.
Fig. 6.
Fig. 5.
Fig. 8.

wheel is fixed on a shaft C, the lower end working in a step fixed on the ground, the wheel being fixed on the shaft upon a level with the tail water in a bay D D, for the floats of the vessel just to work clear, and built secure to prevent the water from dispersing with an opening to that part next the sluice at E, to admit of the water flowing or forcing under the wheel A, which will put the wheel in motion, with a power equal to the head of water. The floats of this wheel may be put upon a perpendicular direction as Fig. 9.

Fig. 8, a water wheel and tunnel for scouring away sand or loose soil for getting a ship off the sand or main; A, the water wheel six feet diameter, more or less, described in section of the wheel, Fig. 6. B B, the frame seven feet square, more or less, of a sufficient depth for the wheels to work clear of the bridge-trees C C, for the upper and lower gudgeons of the shafts that the wheels A E and F, are fixed on to work clear. D D, a circle or bay for the water wheel A to work between. F, a cog wheel about twenty-seven inches diameter, working into a cog wheel E, about nine inches diameter, fixed on the main shaft that the water wheel A is fastened to. At the upper end of the gudgeon of the shaft that wheel F is fixed upon, is an universal joint affixed with a hook or an eye to fasten the end of a small cable or hawser G, by turning round of which, will put the water wheel A in motion; the frame B being covered over with canvas or other fit materials, to prevent the water dispersing out at the top, except upon one square, where an opening must be left about two feet, with a short tunnel H, pointing down to direct the force of the water to scour away the ground: the frame B B must have a ring at each corner to fix ropes K K K K, to lower the frame down within about one foot of the ground, and a rope to each

 of

of the outer corners to guy the frame to that part of the ship where the ground is wanted to be scoured away; the cable G being fastened, one end to the shaft that wheel F works upon, the other end brought on board and fastened to a hook with an universal joint, the work may be put in motion by a wye wheel with an endless rope winch, or other proper means prepared for the purpose, to fix at any part of the ship; the cable to be guyed up at different parts as at I I I, to lead it clear. N. B. The multiplying wheels F and E, if required, may be fixed with the wye wheel, &c. &c. to work at the upper end of the cable on board the ship, and the lower end of the cable being made fast, as before described, to the upper end of the shaft of the water wheel A.

Fig. 9, a wheel twelve feet diameter with a rim A A on the outside, to which the upper part of the floats B are fastened. These floats are to be thirty inches long, more or less, fixed upon an angle of ten degrees, more or less, and connected together by a rim C C at the lower ends, which rim must be kept down close to the bay E, Fig. 2, and at D D, Fig. 7, to prevent as little wind or water as possible passing under the vessel. The upper end at rim A A being closed into the centre, to prevent the wind or water passing through that part of the wheel, the wheel will be put into motion by the water acting against the parts in passing through, according to the head of water; this wheel may likewise be worked perpendicularly, the open part or the rim at the end of the floats C C, to work as close to one side of the bay as possible for the wheel to have freedom to work; by letting the water into the wheel through that side of the ends to which the floats are fastened, fronting the stream or tide when the water is forcing through between the floats, will put the wheel in motion to carry forward any

work

work according to the strength. N. B. When the wheel is made to work in the tide, then the floats may be twelve feet long, more or less. The scouring away the ground for getting ships off the sand (as per Fig. 8.) being an entire new principle, though it is evident it may be performed by various other machinery, yet I conceive that will be an infringement of my Patent.

In witness whereof, &c.

Specification of the Patent granted to JAMES BEVANS, *of Castle Street, City Road, in the County of Middlesex, Carpenter, being one of the Society of the People called Quakers; for Methods of applying Machinery for the Purposes of more expeditiously striking or sticking Mouldings, and for rabbetting, ploughing, or grooving, fluting, and excavating Wood in every Manner now usually performed by any Kind of Plane.*

Dated November 19, 1803.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Bevans do declare, that the object of my invention is to perform the operations of striking or sticking mouldings, rabbetting, ploughing, grooving, fluting, or excavating wood in a much more expeditious manner than that now practised, by substituting in lieu of manual labour the machinery hereafter described.

These operations are to be performed by the planes or other instruments now used for similar purposes, or with such alterations as are necessary to adapt them to the machinery. These instruments are to be used either singly or combined in any number, according to the

 width

width of the board or boards to be worked at once, and according to the nature of the work to be done. The instruments are made to pass horizontally over the material (which is to be firmly fixed in the usual manner) in the direction of the mouldings, grooves, flutes, or other work, by a connecting rod or shaft communicating at one end with the instruments, with the box or frame containing the same, with the quadrants, or with the bearing shaft, (all of which are more particularly described in the drawings hereunto annexed), and at the other end with machinery, capable of affording a reciprocating motion.

This machinery may consist of a crank; whose radius must be nearly half the length of the required stroke, and must be regulated accordingly; this regulation may be effected by the arm of the crank, passing through a mortise in a strong box fixed on an axis, and sliding in the said box to any required length, where it must be fixed by strong screws, the axis being turned by manual exertion, by horses, water, steam, or any other power, and having its motion regulated by a fly-wheel or otherwise. I claim no exclusive privilege for the invention of this part of the machinery, but have described the same as an example of a simple method of giving a reciprocating motion.

In the drawing annexed to this specification, (see Plate VIII.) Fig. 1, shews the side of the box or frame containing the planes or other instruments, with the quadrants and bearing shaft. Fig. 2, the end of the same. Fig. 3, a horizontal section in the line *w x*. Fig. 4, a vertical section in the line *y z*. The references to each part are the same in all the figures.

A, the planes (in this instance three) notched out, as are the blanks B, to fit the end of the box or frame at C,

and

and fixed firmly by screws and nuts, which are moveable in the metal slips D, according to the number and situation of the planes; E E, are two quadrants, placed one on each side of the box or frame, and resting on the tongues F, which form rabbets, in which chains connecting the quadrants with the sides of the box or frame may be, without being subjected to the pressure of the quadrant. It is hardly necessary to observe that cords or straps may be substituted for the chains—in this latter case the tonge F may be omitted. G is a moveable upright shaft, which I term (from its pressure on the box or frame and the planes) a bearing shaft, fixed at its lower end to the two quadrants, and its upper end sliding between friction wheels, or otherwise, in a tube, hung on two pivots perpendicularly over the centre of the work, and at such height as may be most convenient for the length of stroke required, as may be seen in Fig. 5. H is the connecting rod or shaft, which in this instance turns on a joint at the lower end of the bearing shaft; its connection with the crank rod, which gives the required motion, is shewn in Fig. 5; I I, are fences sliding perpendicularly in tubes or sockets in the box or frame, and clipping a tongue K, fixed, in the direction of the required stroke, in the frame supporting the bench. Instead of these may be substituted fences similar to those of a common plough, or a tongue, fixed either to the planes or to the box or frame containing them, may slide in a groove in the bench or its frame, or the said box or planes may slide with or without friction rollers between direction pieces fixed for that purpose. In some cases it will be more convenient for the bearing shaft to be fixed at the upper end to a centre or axis over the work, and to slide at bottom in a tube affixed between or above the quadrants. In other instances the bearing shaft may be entirely

entirely omitted, the quadrants being retained in their position by sliding in grooves, fixed a little above their centres, in which case stops are to be affixed at each end of the stroke to tilt the quadrants, and by this means effect the purpose intended to be answered by the bearing shaft, of supporting that end of the planes which is off the wood, by throwing the pressure of the quadrants on the other end of the same; but in this case the connecting rod must be fixed to the box or frame.

The Figs. 1, 2, 3 and 4, are drawn to a scale of three inches to the foot. And Fig. 5, is drawn to the scale of half an inch to the foot *.

In witness whereof, &c.

Specification of the Patent granted to ELIZABETH BELL, *of Hampstead, in the County of Middlesex, Spinster; for an artificial Method of sweeping Chimneys, and of constructing them in such a Manner as to lessen the Danger and Inconvenience from Fire and Smoke.*

Dated May 10, 1803.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Elizabeth Bell, in pursuance of the said proviso, in the said letters patent, do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed; that is to say: My artificial method of sweeping chimneys is carried into effect by means of certain apparatus, fixed, or applied, or used at the top and bottom of the flue of any chimney, by means of which a chain or rope can be drawn up and down, and is made to carry certain other apparatus, consisting of brushes or scrapers, or other fit instruments for

* These drawings have been reduced to suit the size of our plate.

cleansing

cleansing the chimneys, and I do construct and make all the said apparatus, instruments, and things so intended to be used, of various forms, and in various relative operations, as are hereafter more particularly set forth; that is to say:

First, I fix on the top of the chimney, or stack of chimneys, a frame, consisting of rods of iron, or other fit metal or materials, united at top either by cross bars or otherwise, or meeting in a point; which said frame is intended to form a support for one or more pullies or rollers, for the purpose of leading or conducting a metallic chain or rope from the bottom of the chimney to the top, and thence downwards, to support and work the sweeping apparatus; should any apprehension be entertained, that the point of the above bars should attract lightning, the usual conductors may easily be attached to it.

Secondly. One of the sweeping apparatus consists of a block, body, or main-piece of wood, or other proper material, in the form of a square prism, or of such other form, and of such length, as may be found convenient with regard to the chimneys intended to be swept, and a pipe or tube is to be passed through the middle of the said block, body or main-piece, and fixed therein, usually in the direction of the greatest dimension or length of the same. One extremity of the chain before described is fixed to the upper part of the said block, body or main-piece, and serves to raise or lower the sweeping apparatus or sweeper when introduced into the chimney, and the other part of the aforesaid chain, after passing over the pulley or rollers at the top of the chimney, is returned and conveyed down to the bottom, through the said tube, which defends and prevents it from touching or injuring the other parts of the said sweeping apparatus. It must, therefore, be understood, that the position of the said block,

block, body or main-piece when in the chimney must usually be such that the said tube will be in an upright position. To the sides of the said block, body or main-piece are affixed certain levers or bars, each moving severally on its own joint in planes of direction, or from the central tube aforesaid; but, nevertheless, so loosely as to the said joint that the said lever shall be also capable of moving to the right and to the left of the said several planes of motion. The joint in each of the said levers is usually at some point nearer the upper than the lower extremity thereof, and the said lower extremities are fitted up or armed with brushes or brooms of hair wire, or other fit material, or scrapers of wood or metal, for the purpose of sweeping and cleansing the chimney, when the sweeping apparatus shall be drawn up and down by means of the chain. From each of the said levers I pass a cord or rope over a pulley duly placed in the block, body or main-piece aforefaid, wherein the same is fastened to a weight lodged within a cell to the said block, body or main-piece, and the said weights serve by their reaction to urge the lower extremities of the levers outwards against the sides of the chimney with a due pressure, and the levers on each side are provided with strings and a weight as aforesaid.

Or otherwise, I produce the same outward pressure by means of springs of the kind called curb-springs, or of any other of the well-known forms proper to answer that purpose.

And farther, I cause other ropes or cords to pass from the lower branches of the said levers through a ring or eye, and over a friction roller or rollers, near the extremity of the middle tube before described, in such a manner that all the said ropes shall unite in one, and pass downwards, so as to give the workman or operator the power of drawing the lower branches together when any

occasion

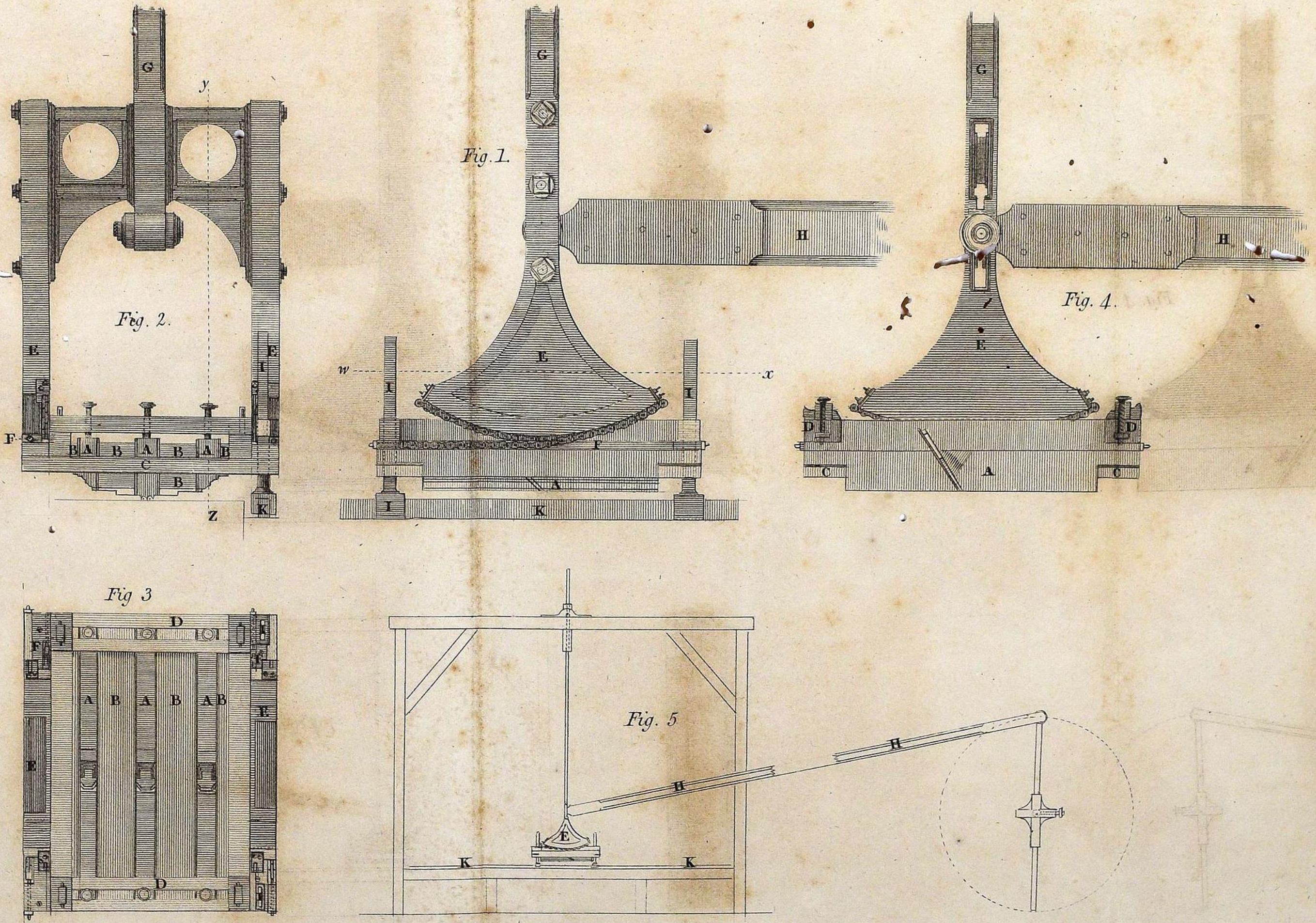
Fig. 2.
Fig. 1.
Fig. 4.
Fig 3
Fig. 5

occasion may render the same necessary. The tube or pipe must be long enough above the top of the levers to pass up the pot at the top of the chimney, and must be armed or fitted with a proper brush to sweep and cleanse the upper part of the chimney above the space where the sweeper is allowed to ascend, and the ascent of the said sweeper must be limited, by means of a stop of any fit figure, to apply against the framing at top, when its sweeper is at its intended limit.

Thirdly, Instead of the sweeper herein-before described, I sometimes construct and use another middle or intermediate apparatus, consisting of a structure of the form of an egg, or nearly so, made of wood and leather, or other flexible material, and covered with brushes of hair or wire, or scrapers, as may be requisite. I call this my elastic sweeper, and I construct the same of three, four, or more pieces of wood connected together longitudinally, or otherwise, in the direction intended to coincide with that of the flue of the chimney. And as it is my intention that the said pieces of wood should possess a power of elastic expansion or relative motion outwards, and also yield inwards when compressed by the narrowness of the flue, or by any other force, I connect and join the same by means of leather or cloth, in the manner of bellows, or by cords, or jointed rods, or otherwise, so as to admit of the said expansion or relative motion; and I give and produce the requisite elasticity by springs duly placed within; and the said springs may be strait or helical, or of any other figure, provided only that the same be so made and placed as to cause the said pieces of wood duly to recede from each other, whenever the absence of external pressure, or the state of the leather, or flexible connecting material, shall permit the said effect. The elastic sweeper here described being drawn up

and down the flue of any chimney, will sweep and cleanse the same, and will, in some cases, be preferable to the sweeper first described.

Fourthly, The apparatus at the bottom of the chimney consists of a frame of wood, or other material, so made as entirely to cover the front or opening of the chimney into the room, and to defend the hearth, the grate, and the apartment, from the soot. The use and application of this frame affords sufficient instruction to a workman to construct the same. Upon the frame within the chimney I place two or more rollers, for the purpose of working the chain, by means of handles attached to the axis, which pass through the wooden frame into the apartment; so that, with one roller to raise, and another to draw down the sweeper, the whole operation becomes perfectly manageable and easy. And I usually form an opening in the frame, closed by a flap or door, through which the working can be occasionally examined, and the cords, chains, or strings, for regulating the levers, may be accessible, and every other necessary attention paid to the process.

Fifthly, I do likewise carry my said artificial method into effect, in other cases, by an apparatus consisting of rods of iron fixed at the top of the chimney as before, but terminating in one common place of junction, from which a spindle or vertical bar descends into the chimney, and serves as the support for a frame, either square, or nearly answering to the figure of the chimney, within which it is thus supported on a level, without touching the walls, and serves to support, sustain, or bear out a chain near the walls or inner surface of the chimney; and the said chain carries a brush, or proper implement or instruments for sweeping and cleansing the chimney when drawn up and down therein. Another frame, nearly similar, is to be placed at the bottom of the chimney,

and

and the brush will sweep the different parts or sides of the said chimney, accordingly as the same shall be drawn up and down against the different sides of the said frames; and in this construction or apparatus for carrying my said artificial method into effect, I pass the chain over a pulley at the top as before, but moveable by a swivel. And I do also occasionally, or for the most part, fix the axis of my lower rollers for the chain in a swivel-piece, by which the same can be adapted to the different situations; and, instead of handles as aforesaid, I work the said rollers by a crank, or by any other obvious and well-known method or means. In some cases also, I place a wheel of metal or wood on the said spindle or vertical bar, to regulate the situations of the chain as to the different sides of the chimney; and I use the said wheel either with or without the frame within the chimney; and I regulate the said positions or situations by a rotatory motion in the said wheel at the top, or by a correspondent and similar wheel at the bottom, at pleasure. And in all these, and similar operations described under the title fifthly, I occasionally groove or flute the face of my working rollers, in order that the chain may move, or be led in any one of the same at pleasure. Or otherwise, I cause the chain to pass through the notches of a rack, for the same purpose.

Sixthly, In some chimneys, instead of the elastic sweeper, I simply use a cylinder, fixed with brushes of hair or wire, or scrapers, which is worked as first shewn and explained.

Seventhly, I sometimes produce a rotatory motion, by a wheel filled with a sufficient quantity of cord, which is put upon the chain, and drawn up and down the chimney.

And, generally, in case the chimney required to be swept or cleansed should be actually on fire, I then attach to the chain of any of the apparatus herein-before described, a vessel of tin, or other material not liable to be

broken, and filled with water, which vessel is provided with a valve, or sheet or slider, at its lower part, which may be opened by pulling a line or small chain; and will thereby permit the water to flow out through a simple aperture or spreading nozel; and I, by the means aforesaid, convey the said vessel to the place where the fire is burning, or to a higher situation, and thus extinguish the same by letting out the water from the vessel.

Lastly, My method of constructing chimneys consists in forming certain blocks or masses of brick or pottery, or other sufficiently cheap, durable, and incombustible materials, having a perforation of the dimensions of the intended flue and serving to form a part or portion of the sides or walls thereof, as to the whole circumference or dimensions of the same, taken horizontally, or in a section across the said flue; and I build the chimney by placing the said blocks, bricks, or masses, upon or beside each other, so that the cavities therein shall form one flue; and for the more perfect application and joining of the same, I fashion the said blocks or masses with projecting fittings, which enter and close within each other, as is seen in some snuff-boxes, or with other fittings or overlappings, suitable and proper for the purpose; and I make good the joining with mortar or plaster, or luting or loam, or iron cramps, with lead or metallic hooping, or in any other good and workman-like manner, so as to exclude all possibility of any communication of fire to the beams or other part of the house. And, in order to form the angles, deflections, or curvatures of chimneys, I fashion or make some of my blocks or masses with the faces of application inclined to each other, and not parallel, as for the most part I do make them; and I do make the internal cavity, and external surfaces, of such dimensions and figure as may best suit the intended purpose.

In witness whereof, &c.

Specification

Specification of the Patent granted to James Roberts, *of Abbotston Farm, in the County of Southampton, Yeoman, and* George Cathery, *of New Alresford, in the same County, Gentleman; for completely and effectually eradicating Smut from Wheat; and that Wheat when cleansed by this Invention will produce Flour of as good Quality and Value as Flour made from Wheat of the best Growth.* Dated July 6, 1803.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, we the said James Roberts and George Cathery do hereby describe and ascertain the nature of our said invention, and in what manner the same is to be performed, as follows, that is to say: The said invention for eradicating smut from wheat consists of mixing the same with lime made from stone, or white or grey chalk, and is used in the following manner; namely, the lime, when slack, to be sifted through a fine sieve, and then mixed well with the wheat, in proportion to the degree of smut, from one to two bushels to a load of five quarters; it then must be passed through a machine; in general once will be sufficient to make the wheat fit for the miller, but, if intended for sale, it will frequently be necessary to pass the wheat through the machine twice, and in some cases three times. The machine is made of wire, with brushes within, upon the same principle as the machine in common use for dressing flour, except that the wire is stronger and coarser.

In witness whereof, &c.

Account

Account of some Experiments on the Descent of the Sap in Trees. By THOMAS ANDREW KNIGHT, *Esq.*

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY.

IN a Memoir which I had the honour to present to you two years ago *, I related some experiments on trees, from which I inferred, that their sap, having been absorbed by the bark of the root, is carried up by the alburnum or white wood, of the root, the trunk, and the branches: that it passes through what are there called the central vessels, into the succulent part of the annual shoot, the leaf-stalk, and the leaf; and that it returns to the bark, through the returning vessels of the leaf-stalk. The principal object of this Paper is, to point out the causes of the descent of the sap through the bark, and the consequent formation of wood.

These causes appear to be, gravitation, motion communicated by winds or other agents, capillary attraction, and probably something in the conformation of the vessels themselves, which renders them better calculated to carry fluids in one direction than in another. I shall begin with a few observations on the leaf, from which all the descending fluids in the tree appear to be derived. This organ has much engaged the attention of naturalists, particularly of M. BONNET; but their experiments have chiefly been made on leaves severed from the tree; and, therefore, whatever conclusions have been drawn, stand on very questionable ground. The efforts which plants always make to turn the upper surfaces of their leaves to

* See Phil. Trans. for 1801, p. 333.

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the light, have with reason induced naturalists to conclude, that each surface has a totally distinct office; and the following experiments tend strongly to support that conclusion.

I placed a small piece of plate glass under a large vine leaf, with its surface nearly parallel with that of the leaf; and, as soon as the glass had acquired the temperature of the house in which the vine grew, I brought the under surface of the leaf into contact with it, by means of a silk thread and a small wire, adapted to its form and size. Having retained the leaf in this position one minute, I removed it, and found the surface of the glass covered with a strong dew, which had evidently exhaled from the leaf. I again brought the leaf into contact with the glass, and, at the end of half an hour, found so much water discharged from the leaf, that it ran off the glass when held obliquely. I then inverted the position of the leaf, and placed its upper surface in contact with the glass: not the slightest portion of moisture now appeared, though the leaf was exposed to the full influence of the meridian sun. These experiments were repeated on many different leaves; and the result was, in every instance, precisely the same. It seems, therefore, that in the vine the perspiratory vessels are confined to the under surface of the leaf: and these, like the cutaneous lymphatics of the animal economy, are probably capable of absorbing moisture, when a plant is in a state to require it. The upper surface seems, from the position it always assumes, either formed to absorb light, or to operate by the influence of that body; and, if any thing exhale from it, it is probably vital air, or some other permanently elastic fluid. It nevertheless appears evident, in the experiments of Bonnet, that this surface of the

leaves

leaves of many plants, when detached from the tree, readily absorbs moisture.

Selecting two young shoots of the vine, growing perpendicularly against the back wall of my vinery, I bent them downwards, nearly in a perpendicular line, and introduced their succulent ends, as layers, into two pots; without wounding the stems, or depriving them of any portion of their leaves. In this position, these shoots, which were about four feet long, and sprang out of the principal stem about three feet from the ground, grew freely, and, in the course of the summer, reached the top of the house. As soon as their wood became sufficiently solid to allow me to perform the operation with safety, I made two circular incisions through the bark of the depending part of each shoot, at a small distance from each other, near the surface of the mould in the pots; and I wholly removed the bark between the incisions; thus cutting off all communication, through the bark, between the layers and the parent stems. Had the subjects of this experiment now retained their natural position, much new wood and bark would have been formed at the upper lip of the wounds, and none at all at the lower, as I have ascertained by frequent experiment. The case was now different: much new bark and wood was generated on the lower lip of the wounds, become uppermost by the inverted position of the branches; and I have no doubt but that the new matter, thus deposited, owed its formation to a portion of sap, which descended by gravitation, from the leaves growing between the wounded parts and the principal stems.

The result of this experiment appears to point out one of the causes why perpendicular shoots grow with much greater vigour than others: they have probably a more perfect and more rapid circulation.

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The effects of motion on the circulation of the sap, and the consequent formation of wood, I was best able to ascertain by the following expedient. Early in the spring of 1801, I selected a number of young seedling apple trees, whose stems were about an inch in diameter, and whose height, between the roots and first branches, was between six and seven feet. These trees stood about eight feet from each other; and, of course, a free passage for the wind to act on each tree was afforded. By means of stakes and bandages of hay, not so tightly bound as to impede the progress of any fluid within the trees, I nearly deprived the roots and lower parts of the stems, of several trees, of all motion, to the height of three feet from the ground, leaving the upper parts of the stems and branches in their natural state. In the succeeding summer, much new wood accumulated, in the parts which were kept in motion by the wind; but the lower parts of the stems and roots increased very little in size. Removing the bandages from one of these trees in the following winter, I fixed a stake in the ground, about ten feet distant from the tree, on the east side of it; and I attached the tree to the stake, at the height of six feet, by means of a slender pole about twelve feet long; thus leaving the tree at liberty to move towards the north and south, or, more properly, in the segment of a circle, of which the pole formed a radius; but in no other direction. Thus circumstanced, the diameter of the tree from north to south, in that part of its stem which was most exercised by the wind, exceeded that in the opposite direction, in the following autumn, in the proportion of thirteen to eleven.

These results appear to open an extensive and interesting field to our observation, where we shall find much to admire, in the means which nature employs to adapt the

forms of its vegetable productions to every situation in which art or accident may deposit them. If a tree be placed in a high and exposed situation, where it is much kept in motion by winds, the new matter which it generates will be deposited chiefly in the roots and lower parts of the trunk; and the diameter of the latter will diminish rapidly in its ascent. The progress of the ascending sap will of course be impeded; and it will thence cause lateral branches to be produced, or will pass into those already existing. The forms of such branches will be similar to that of the trunk; and the growth of the insulated tree on the mountain will be, as we always find it, low and sturdy, and well calculated to resist the heavy gales to which its situation constantly exposes it.

Let another tree of the same kind be surrounded, whilst young, by others, and it will assume a very different form. It will now be deprived of a part of its motion, and another cause will operate: the leaves on the lateral branches will be partly deprived of light, and, as I have remarked in the last Paper I had the honour to address to you, little alburnum will then be generated in those branches. Their vigour, of course, becomes impaired, and less sap is required to support their diminished growth: more, in consequence, remains for the leading shoots; these, therefore, exert themselves with increased energy; and the trees seem to vie with each other for superiority, as if endued with all the passions and propensities of animal life.

An insulated tree in a sheltered valley, will assume, from the foregoing causes, a form distinct from either of the preceding *; and its growth will be more or less aspiring,

* Not only the external form of the tree, but the internal character of the wood will be affected by the situation in which the tree grows; and

aspiring, in proportion to the degree of protection it receives from winds, and its contiguity to elevated objects, by which its lower branches, during any part of the day, are shaded.

When a tree is wholly deprived of motion, by being trained to a wall, or when a large tree has been deprived of its branches, to be regrafted, it often becomes unhealthy, and not unfrequently perishes, apparently owing to the stagnation of the descending sap, under the rigid cincture of the lifeless external bark. I have, in the last two years, pared off this bark from some very old pear and apple-trees, which had been re-grafted with cuttings from young seedling trees, and the effect produced has been very extraordinary. More new wood has been generated in the old trunks, within the last two years, than in the preceding twenty years; and I attribute this to the facility of communication which has been restored between the leaves and the roots, through the inner bark. I have had frequent occasion to observe, that wherever the bark has been most reduced, the greatest quantity of wood has been deposited.

Other causes of the descent of the sap towards the root I have supposed to be capillary attraction, and something in the conformation of the vessels of the bark. The alburnum also appears, in my former experiments, to expand and contract very freely, under changes of temperature and of moisture; and the motion thus pro-

and hence, oak timber which grew in crowded forests, appears to have been mistaken, in old buildings, for Spanish chesnut. But I have found the internl organization of the oak and Spanish chesnut to be very essentially different. The silver grain and general character of the oak and Spanish chesnut, are also so extremely dissimilar, that the two kinds of wood can only be mistrken for each other by very careless observers. Many pieces of wood found in the old buildings of London, and supposed to be Spanish chesnut, have been put into my hands; but they were all most certainly forest oak.

duced must be in some degree communicated to the bark, should the latter substance be in itself wholly inactive. I however consider gravitation as the most extensive and active cause of motion, in the descending fluids of trees; and I believe, that from this agent, vegetable bodies, like unorganized matter, generally derive, in a greater or less degree, the forms they assume; and probably it is necessary to the existence of trees that it should be so. For, if the sap passed and returned as freely in the horizontal and pendent, as in the perpendicular branch, the growth of each would be equally rapid, or nearly so: the horizontal branch would then soon extend too far from its point of suspension at the trunk of the tree, and thence must inevitably perish, by the compound ratio in which the powers of destruction, compared with those of preservation, would increase.

The principal office of the horizontal branch, in the greatest number of trees, is to nourish and support the blossoms, and the fruit or seed; and, as these give back little or nothing to the parent tree, very feeble powers alone are wanted in the returning system. No power at all had been fatal; and powers sufficiently strong wholly to counteract the effects of gravitation, had probably been in a high degree destructive. And it appears to me by no means improbable, that the formation of blossoms may, in many instances, arise from the diminished action of the returning system in the horizontal or pendent branch.

I have long been disposed to believe the ascending fluids in the alburnum and central vessels, wherever found, to be everywhere the same; and that the leaf-stalk, the tendril of the vine, the fruit-stalk, and the succulent point of the annual shoot, might in some measure be substituted for each other; and experiment has proved

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my conjecture, in many instances, to be well founded. Leaves succeeded, and continued to perform their office, when grafted on the fruit-stalk, the tendril, and succulent shoot, of the vine; and the leaf-stalk, the tendril, and the fruit-stalk, alike supplied the branch grafted upon them with nourishment. But I did not succeed in grafting a fruit-stalk of the vine on the leaf-stalk, the tendril, or succulent shoot. My ill succes, however, I here attribute solely to want of proper management; and I have little doubt of succeeding in future.

The young shoots of the vine, when grafted on the leaf-stalk, often grew to the length of nine or ten feet; and the leaf-stalk itself, to some distance below its juncture with the graft, was found, in the autumn, to contain a considerable portion of wood, in every respect similar to the alburnum in other parts of the tree.

The formation of alburnum in the leaf-stalk seemed to point out to me the means of ascertaining the manner in which it is generated in other instances; and to that point my attention was in consequence attracted. Having grafted a great many leaf-stalks with shoots of the vine, I examined, in transverse sections, the commencement and gradual formation of the wood. It appeared evidently to spring from the tubes which, in my last Paper, (to which I must refer you,) I have called the returning vessels of the leaf-stalk; and to be deposited on the external sides of what I have there named the central vessels, and on the medulla. The latter substance appeared wholly inactive; and I could not discover any thing like the processes supposed to extend from it, in all cases, into the wood.

The organization of the young shoot is extremely similar to that of the leaf-stalk, previous to the formation of wood within it. The same vessels extend through both; and

and therefore it appeared extremely probable, that the wood in each would be generated in the same manner; and subsequent observation soon removed all grounds of doubt.

It is well known that, in the operation of budding, the bark of trees being taken off, readily unites itself to another of the same or of a kindred species. An examination of the manner in which this union takes place, promised some further information. In the last summer, therefore, I inserted a great number of buds, which I subsequently examined, in every progressive stage of their union with the stock. A line of confused organization marks the place where the inserted bud first comes into contact with the wood of the stock; between which line and the bark of the inserted bud, new wood regularly organized is generated. This wood possesses all the characteristics of that from which the bud was taken, without any apparent mixture whatever with the character of the stock in which it is inserted. The substance which is called the medullary process, is clearly seen to spring from the bark, and to terminate at the line of its first union with the stock.

An examinrtion of the manner in which wounds in trees become covered, (for, properly speaking, they never can be said to heal,) affords further proof, were it wanted, that the medullary processes, (as they are improperly named,) like every other part of the wood, are generated by the bark.

Whenever the surface of the alburnum is exposed but for a few hours to the air, though no portion of it be destroyed, vegetation on that surface for ever ceases. But new bark is gradually protruded from the sides of the wound, and by this new wood is generated. In this wood, the medullary processes are distinctly seen to take

their

their origin from the bark, and to terminate on the lifeless surface of the old wood within the wound. These facts incontestibly prove, that the medullary processes, which in my former Paper I call the silver grain, do not diverge from the medulla, but that they are formed in lines converging from the bark to the medulla, and that they have no connection whatever with the latter substance. And surely nothing but the fascinating love of a favourite system could have induced any naturalist to believe the hardest, the most solid, and most durable part of the wood, to be composed of the soft, cellular, and perishable substance of the medulla.

In my last Paper, I have supposed that the sap acquired the power to gĉnerate wood in the leaf; and I have subsequently found no reason to retract that opinion. But the experiment in which wood was generated in the leaf-stalk, apparently by the sap descended from the bark of the graft, induces me to believe, that the descending fluid undergoes some further changes in the bark, possibly by discharging some of its component part through the pores described and figured by MALPIGHI.

I also suspected, since my former Paper was written, that the young bark, in common with the leaf, possessed a power, in proportion to the surface it exposes to the air and light, of preparing the sap to generate new wood; for I found that a very minute quantity of wood was deposited by the bark, where it had not any apparent connection with the leaves. Having made two incisions through the bark round annual shoots of the apple-tree, I entirely removed the bark between the incisions, and I repeated the same operation at a little distance below, leaving a small portion of bark unconnected with that above and beneath it. By this bark, a very minute quantity

quantity of wood, in many instances, appeared to be generated, at its lower extremity. The buds in the insulated bark were sometimes suffered to remain, and in other instances were taken away; but these, unless they vegetated, did not at all affect the result of the experiment. I could therefore account for the formation of wood, in this case, only by supposing the bark to possess in some degree, in common with the leaf, the power to produce the necessary changes in the descending sap; or that some matter originally derived from the leaves, was previously deposited in the bark: or that a portion of sap had passed the narrow space above, from which the bark had been removed, through the wood. Repeating the experiment, I left a much greater length of bark between the intersections; but no more wood than in the former instances was generated. I therefore concluded, that a small quantity of sap must have found its way through the wood, from the leaves above; and I found, that when the upper incisions were made at ten or twelve lines distance, instead of one or two, and the bark between them, as in the former experiments, was removed, no wood was generated by the insulated bark.

I shall conclude my Paper with a few remarks on the formation of buds, in tuberous rooted plants, beneath the ground. They must, if my theory be well founded, be formed of matter which has descended from the leaves through the bark. I shall confine my observations to the potatoe. Having raised some plants of this kind in a situation well adapted to my purpose, I waited till the tubers were about half grown; and I then commenced my experiment by carefully intersecting, with a sharp knife, the runners which connect the tubers with the parent plant, and immersing each end of the runners, thus intersected, in a decoction of logwood. At the end

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of twenty-four hours, I examined the state of the experiment; and I found that the decoction had passed along the runners in each direction; but I could not discover that it had entered any of the vessels of the parent plant. This result I had anticipated; because I concluded, that the matter by which the growing tuber is fed, must descend from the leaves through the bark; and experience had long before taught me, that the bark would not absorb coloured infusions. I now endeavoured to trace the progress of the infusion in the opposite direction; and my success here much exceeded my hopes.

A section of the potatoe presents four distinct substances: the internal part, which, from the mode of its formation and subsequent office, I conceive to be allied to the alburnum of ligneous plants; the bark which surrounds this substance; the true skin of the plant, and the epidermis. Making transverse sections of the tubers which had been the subjects of the experiments, I found that the coloured infusion had passed through an elaborate series of vessels between the cortical and alburnous substances, and that many minute ramifications of these vessels approached the external skin at the base of the buds, to which, as to every other part of the growing tuber, I conclude they convey nourishment.

Some other experiments were made on this plant, which appeared to me interesting; but my Paper has already a good deal exceeded its intended limits. I will therefore dismiss the subject; but intend to trouble you with another Memoir in the autumn, should this be honoured with the approbation of the Royal Society.

Memoir on the refining of Lead, containing Reflections on the Inconveniencies of Cupels made with Ashes, and Description of a new economical Method of constructing Cupels or Basins for Refining. Read to the National Institute. By M. DUHAMEL, *a Member of the Institute, and Inspector of Mines.*

From the JOURNAL DES MINES.

IT is generally known, that to separate silver from lead a metallurgic process has always been employed, called refining or cupellation, which is performed in a basin, denominated a cupel. It is equally well known that this basin is formed either with the ashes of the bones of animals, or with those of vegetables, after having been lixiviated, to deprive them of the saline particles they contain.

The great quantity of wood-ashes necessary for the construction of cupels, and the difficulty of procuring them, have long induced me to seek a more simple, and less expensive, method of forming the basins in question.

The ancient chemists having observed that lead becomes oxydated, or is reduced to the substance called litharge, when exposed to heat, and to the contact of the atmospheric air, while the silver which is combined with it retains its metallic form, the only point that remained for them to discover was a method of effecting the separation of those two metals. To this discovery they were led by observing that the oxyd of lead, in a state of liquefaction, easily penetrates substances that happen to be in contact with it, particularly into the ashes of the bones of animals, without destroying the figure of the vessels constructed

constructed with them. No other material is so proper for the formation of small cupels for experiments.

The difficulty, and frequently the impossibility of procuring six or eight hectolitres * of bone ashes for each operation on a large scale, in the German furnaces, has caused recourse to be had to wood-ashes. But independent of the expense, and the difficulty of obtaining a sufficient quantity even of these, they are attended with a great disadvantage of being carried away, and floating on the surface of the lead, which renders that operation useless. This takes place whenever the ashes are not well prepared, when the cupel is improperly or unequally formed, or the channels intended for the evaporation of the moisture are neither sufficiently numerous nor suitably arranged, nor covered with a layer of scoria, upon which is placed the bed for the reception of the ashes; this bed should be constructed of the most porous bricks, that the water, with which it is necessary to wet the ashes, may penetrate through them as it evaporates, filtre through the layer of scoria, and run off by means of channels at the bottom of the furnace.

To ascertain the quantity of lead in silver, it is sufficient to put a few grammes into a small cupel of bone-ashes, placed beneath the muffle of an assaying-furnace; as the lead becomes oxydated it sinks into the cupel, and at length becomes incandescent, which shews that all the lead is dissipated, that the silver it contained is refined, and has attained the highest degree of purity.

In refining upon a large scale, the object likewise is to separate the silver from the lead, but not to make the whole of the latter penetrate into the cupel, which indeed is impracticable; because, in that case, a much greater

* A hectolitre is about one hundred quarts English measure.

quantity of ashes would be required for the total absorption of the metal; otherwise the operation would take ten times the usual space of time allowed for each refining, would occasion a tenfold expense in fuel, and a much greater loss in the metals than by the ordinary process, by which the greater part of the lead is obtained in litharge, while a portion penetrates into the cupel, and absorbs about five centimetres of its thickness. This must again be melted, to separate it from the ashes, which reduction is likewise more expensive, and subject to a greater loss than the litharge, which melts with ease, and is fit for the purposes of commerce without again passing through the furnace.

Lead ores and litharge may be melted as in England and the departments of ci-devant Bretagne, in a reverberatory furnace, the beds or basins of which are formed of clay, pounded and moistened. These beds resist the action of the heat and the oxyd of lead during an incessant employment of six or eight months.

The durability of these clay-beds gave me the first idea of the method, which I shall presently propose, for refining-furnaces, where it is required only to oxydate the lead to obtain the metal in litharge, and not to cause the whole of it to be imbibed in the cupels, as is the case in assaying the metal to ascertain what quantity of silver it contains. In the operation on a large scale, the cupel, though of ashes, absorbs only a part of the lead, as I have already stated, when shewing that it would be much more profitable to obtain the whole transformed into litharge, the reduction of which into lead is infinitely easier than that of the oxyd contained in the ashes, which render the fusion more difficult, and whose scoria always contain a proportion of metal.

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In a cupel of ashes formed in an iron oval, the largest diameter of which is fourteen or fifteen decimetres, ($4\frac{1}{2}$ to 5 feet,) and the smallest one metre (something more than a yard), the English refine 1000 or 1,200 myriagrammes (10 to 12 ton) of lead, which is converted into excellent litharge, excepting the small portion that penetrates into the cupel, about seven centimetres only in thickness, and supported by two bars of iron beneath the arch of the furnace. A pair of bellows drives the litharge to the fore part of the furnace, from which it falls without interruption upon the floor of the foundery. To fill up the vacancy occasioned by the running off of the oxyd, a bar of lead is gradually moved within the furnace, which as it melts, keeps the cupel full till the conclusion of the operation.

In giving this brief sketch of the English method of procedure, I only wish to shew that it is possible to perform the operation of refining with cupels formed with a small quantity of ashes: those above-mentioned absorb less than 40 kilogrammes (about 90 lbs.) of oxyd, out of the vast quantity of lead refined in them.

Thus it is clear that metallurgists have always endeavoured to obtain the greatest quantity possible of litharge, and a small proportion of ashes impregnated with oxyd, but not daring to depart from the accustomed process, they continued to form their cupels invariably of ashes.

We have seen that in cupellation, on a small scale, the lead, as it becomes oxydated, penetrates the ashes; when no more remains, a small globule of pure silver of a spherical figure is left at the bottom of the basin. This operation is performed with the greater expedition, as in these small vessels the surface of the basin is always raised in the middle, and consequently the oxyd runs off as if upon an inclined plane to the sides of the cupel, where it is instantly absorbed.

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This is not the case with large cupels, several metres in diameter; in these it is necessary to employ bellows, which not only accelerate the oxydation, but likewise drive the litharge towards the channel made for it to run off.

The inconveniencies, and even the impossibility of making all the lead penetrate into the ashes of large cupels, have already been remarked. Indeed, the oxydation is effected only in that part of the basin exposed to the contact of the air and the wind of the bellows; otherwise the litharge in the middle of the basin, being unable to reach its sides, would remain stagnant, and would consequently oppose the formation of a new layer of oxyd.

This induced metallurgists to drive off this litharge by means of bellows, as fast as it was formed, and to make it run off out of the furnace.

Thus the oxydation takes place only on the surface of the basin, and not towards the bottom; if it were otherwise, the ashes of the cupel would be penetrated to a more unequal depth, in proportion to the length of the operation. On the contrary, I have always observed that the *test* or that portion of the ashes which is absorbed, is not thicker at the centre of the basin than at its circumference, though the lead remains 30 or 40 times as long at the bottom as at the sides, for the melted metal is continually diminishing till all the lead is reduced to litharge, and there remains only the globule of silver at the bottom of the cupel.

If all the lead is absorbed by a cupel for assaying, it is because this small vessel is exposed to an equal heat in every part. A large cupel presenting only its upper surface to the action of the caloric, the oxyd absorbed ceases to penetrate to the point, where the heat is no longer capable

pable of keeping it in fusion; this is the reason why the depth impregnated with it is equal throughout the whole cupel, and from the same cause all the lead cannot be made to penetrate into the ashes.

According to the above observations, it is easy to judge, that if the assay of lead ought to be made in small cupels of bone-ashes, in order that all the oxydated metal may penetrate into and be partly converted into vapor, a contrary method should be adopted with regard to refining on a large scale, when the principal aim should be to accelerate the operation, and to obtain as great a quantity of litharge as possible.

I have already stated that the wood-ashes, of which the cupels are made for operations on a large scale, are expensive, and frequently cannot be obtained in sufficient quantity; that they are, moreover, liable to be injured and even totally destroyed, which is attended with considerable loss. I have to add that, in order to give more weight and consistence to cupels, it is often found necessary to mix with the ashes a considerable quantity of sand, especially if the lead contain any foreign substances, as arsenic, cobalt, antimony, tin, &c. If the lead contain nothing but arsenic, after taking off the first scum, about ten kilogrammes of iron filings should be scattered from time to time over the whole surface of the liquid metal. This iron being lighter than the lead, floats upon it, and absorbs the arsenic, after which it is taken off. Soon after the litharge is formed without any impediment. This method is employed in Saxony.

The necessity of adding sand to the ashes of cupels might have led to the discovery of the method which I propose.

New

New construction of basins for refining.

Without altering the body of the masonry work of the so called German furnaces for refining, care must only be taken to form at the bottom of them a sufficient number of channels for the evaporation of humidity, and to place them in the most proper manner for obtaining this effect. These channels should be covered with a layer of scoria, upon which should be laid a pavement of the most porous bricks, only one brick in thickness.

On this area which should be concave like the bed, on which are piled the ashes of common cupels, lay sand, wetted a little, and if it be not sufficiently tenacious, add one-fifteenth part of clay to give it the necessary solidity, and mix the whole carefully together. This sand must be pounded in the same manner as ashes, for the purpose of consolidating it, and formed into a basin, for refining of equal thickness in every part. The thickness of this cupel should be 15 or 16 centimetres; and it may be made of two layers as we shall presently see.

After the basin has been uniformly pounded in every part, shake through a sieve over its whole surface 2 or 3 litres of lixiviated wood-ashes, which must be made to adhere by means of the pestles.

The cupel being thus prepared, lower the cover of the furnace, and make in the grate a moderate fire, which must be kept up several hours to produce the evaporation of part of the water with which the sand has been wetted; the surplus will be dissipated without inconvenience, by means of the channels for evaporation during the refining.

When sufficiently dry, raise the cover of the furnace, suffer the cupel to cool a little, cover it with straw or hay, then arrange the bars or pigs of lead, laying them

down

down gently that their weight may not make any impression upon the sand; it is to prevent this depression that straw should be put, as is the practice in cupels of ashes *.

After the quantity of lead required to fill the cupel is arranged in the furnace, let down the cover, lute it all round with hardened clay, then make a fire as in the usual process of refining.

When the lead is in perfect fusion and covered with scum and carbonified straw, this scum or dross should be removed in the way of litharge, by means of a piece of board about three decimetres in length, in the middle of which must be fixed an iron rod of sufficient length to reach across the furnace, about a yard at most.

After the lead has been well scummed several times and begins to turn red, let the bellows begin to act, but only gently at first. Their nozzles should be placed in such a manner, that the wind from both should be directed to the centre of the cupel; and that this wind may always be carried to the liquid metal, a small round iron plate should be fixed to the end of each nozzle. These suckers are employed in German furnaces for refining, being suspended by hinges from the top; each puff of the bellows turns them half round, and they repel the air towards the metal, thus accelerating the oxydation.

When all the scum is taken off and the lead has become red, and is covered with a layer of litharge, with the small iron hook for that purpose, make a hole in the sand of the cupel, level with the surface of the metal, hollowing it gradually and with care; then the

* Instead of bars it is more adviseable to cast the lead in semispherical iron pots, as in that form it would be less liable to injure the cupel.

litharge driven by the wind to the front of the furnace will run off through this channel, and fall upon the area of the foundery as in the common process of refining.

When the refiner perceives that very little lead is left near the hole, he must close it up with some wet ashes, but as soon as the lead is covered afresh with oxyd, the channel must be again opened according to the height of the metal, taking care to suffer no lead to escape, especially towards the end of the operation, as it might carry with it a considerable quantity of silver which would be lost. In this manner proceed till the silver has become incandecent, observing to augment the fire in proportion to the diminution of the metal, more particularly when the operation is nearly finished, because then the silver is collected together; and as it is more difficult to be kept in fusion than the small quantity of lead which remains united with it, it could be but very imperfectly separated with an insufficient degree of heat; and instead of about one-twentieth of lead, which silver usually retains in the German process, it would have a much more considerable quantity, which would render it much more difficult to pass to the second operation called the refining of the silver, whereby it is brought to any degree of purity that is required.

Those who are accustomed to refine lead in the German method will be able to do it by the method that I propose; for though the cupel is of sand instead of ashes, the operation must be performed in the same manner.

We have seen that the English refine a great quantity of lead in a small cupel, and a great quantity of that metal may be passed through that which I propose, by adding more in proportion as the oxydated lead is driven off.

Supposing

Supposing the cupel to be capable of containing 4 or 500 myriagrammes of lead, above 1500 may be refined by a single operation, without the inconveniences of the English process.

I even flatter myself that a cupel well made with sand will serve for several operations, without being obliged to construct it afresh each time, as in those made of ashes; but in this case the hole or channel, previously made for the litharge to run off, must be filled with sand after removing with a chisel a kind of varnish which the oxyd leaves upon the sides of this channel; that the fresh sand made rather damp may unite with the old, which it will likewise be necessary to wet around that part.

The durability of beds of earth in reverberatory furnaces, where lead ores and even litharges are melted, as I have stated above, will remove all apprehension relative to the action of the oxyd of the lead, which will affect only the surface of the cupel, and will penetrate it but to a very small depth.

After one or more operations this crust may be removed, and fused in a hand-furnace to separate the lead from it; a process which will be as easy as the reduction of the metal contained in the ashes of ordinary cupels, and in much less quantity. Thus more lead will be obtained by the new than by the old method, which will be an advantage, as I have before observed. I shall add, that as the bottom of the sand does not absorb as much oxyd of lead as that of the ashes, it will not contain as much silver, for it is known that the lead separated from these ashes contains much more of the former metal than that proceeding from the reduction of litharge.

Instead of sand, argillaceous earth may be employed for the construction of the cupels, as is practised for the

beds of the reverberatory furnaces in the province of Bretagne; but this earth ought to be pounded several days successively, otherwise it would be liable to crack; and these cracks would continually increase in consequence of the shrinking caused by the caloric; the lead would insinuate itself into these clefts, an inconvenience which cannot take place with sand even if somewhat earthy. I must still observe, that a cupel of earth would grow too hard to permit the formation of a channel for the litharge; in this case the place where the oxyd is to run off should be made of sand or lixiviated ashes.

I shall add, that it will be advantageous to employ two kinds of sand to form the basin of the cupel, the one fine, like that for moulding, the other coarser, and not earthy; the first layer should be made of the latter, about eight centimetres in thickness, after it has been well pounded with pestles for the purpose. Upon this first bed lay the fine sand, somewhat earthy, which will form the second, and must be pounded like the former; both these beds should be wetted a little before they are removed to the furnace, that they may the better combine, and be consolidated by the pestles.

The sand of the lower bed being coarser than that of the upper will absorb its humidity as it drains off, and will suffer it to pass without impediment into the channels made for that purpose.

The lower bed of sand may be left when a fresh cupel is to be made with fine sand, and that portion of the latter which has not been impregnated with oxyd must be mixed afresh, for the construction of the cupel. Attention must be paid when taking away this sand not to meddle with the lower bed, as the coarse sand of the latter

ter must by no means be mixed with the other. This inconvenience may be avoided by spreading upon the bed of coarse sand a thin layer of ashes, where the operator must stop when removing the fine sand of the upper bed.

It has been observed that the moulding sand should be somewhat earthy, and that, if it be not, it is necessary to add a small quantity of clay to give it adhesion; but as this clay must be equally distributed through every part of the sand, it should be diluted in the water used for wetting the sand, and the whole ought then to be mixed with care.

It may be objected, that as the cupels of sand do not absorb as much litharge as those of ashes, more time would be required to perform the operation, since, in the new process, the oxyd instead of being absorbed is carried off out of the furnace. On this head no apprehension need be entertained, for the wind of the bellows, when properly directed, will make the litharge run off by the channel more abundantly than if absorption took place.

I have seen refiners in Germany who construct their cupels with ashes, and practise the judicious method of forming in the middle a small circular hole, the diameter of which is proportioned to the quantity of silver they know to be contained in the lead of one operation. By means of this disposition, no grains of that precious metal remain separate from the lump; the whole is collected in the basin in the centre, and forms a perfectly round cake. I recommend the same practice in the construction of cupels of sand.

I am convinced that the cupels which I propose, if made with care and judgment, will be found to succeed perfectly

perfectly well, and that they will be very economical without possessing the inconveniencies of those made of ashes. For the advantage of metallurgy, I am axious that the method pointed out in this memoir should be put in practice; it will prove that we ought not always blindly to follow old customs, or the routine of workmen.

On the different Combinations of Cobalt with Oxygen; with Observations on various ammoniaco-metallic Salts.

By M. Thenard.

Extracted by M. Drappier.

From the Journal des Mines.

IT has been long known, and especially since the memoir of M. Tessaert, inserted in the Annales de Chimie *, that if an alkali be poured into a solution of cobalt, a precipitate is obtained at first of a laylock colour; that with excess of alkali this precipitate becomes successively blue and olive; that it grows brown by desiccation, and at length turns black. These phenomena had been before attributed to the influence of the air; but M. Thenard, whose accuracy is well known, has ascertained, by experiments, that the absorption of oxygen, which had till then been only suspected, is the real cause of it. That chemist, by examining the action of the air, with and without the aid of heat and that of oxygenated muriatic acid on olive-coloured oxyd of cobalt, has found that the oxyd first turned to a dark brown, and afterwards

* Vol. XXVIII. p. 84.

to

to a deep black. In both these states the oxyds, prepared with either of the re-agents, possess the following properties.

The black oxyd dissolves with effervescence in muriatic acid; and a considerable quantity of oxygenated muriatic acid is disengaged. In nitric and sulphuric acid the solution is more difficult, and requires a longer time. It is accompanied with bubbles, which M. Thenard presumes to be oxygen gas.

The brown and olive-coloured oxyds produce, with those acids, the same phenomena as black oxyd, with this difference, that their action is less powerful; that of the olive-coloured oxyd being still weaker than the other.

The olive-coloured oxyd is prepared by pouring potash into a solution of cobalt. A blue precipitate is formed, which becomes green by exposure to the air. If this oxyd, while yet damp, be treated with weak muriatic acid, by means of a gentle heat it emits oxygenated muriatic acid; it is therefore evident that it has absorbed the oxygen of the air; but, to remove all doubt on this head, M. Thenard put a quantity of blue oxyd into a bottle, and carefully corked it up; in the space of a few minutes a vacancy appeared, and the air that remained could with difficulty be inflamed.

The same chemist likewise submitted the blue oxyd to the action of those acids, but this oxyd, prepared in the manner above described, is extremely fine, and if it come ever so little into contact with the air it almost instantly turns green: on this account M. Thenard preferred to prepare it by disoxygenating the black oxyd; that is, by submitting it for half an hour to a red heat. M. Tessaert was the first that perceived and described that phenomenon; he attributed it to the presence of a

small

small quantity of arsenic, which he suspected to exist in his cobalt, because he could produce it only once, and because he had obtained a light blue, approaching to a violet, by heating arsenious acid with oxyd of cobalt.

The blue oxyd differs from all the others in dissolving in acids without any disengagement of gas; it resembles them in other respects, as the solution of it in concentrated muriatic acid is green, as it passes to a purple by exposure to the air for several hours, and to a rose colour instantly upon the addition of water. This remark furnished the means of explaining why characters made with muriate of cobalt appear of a beautiful pea-green when held to the fire, and disappear when removed from it: the heat concentrates the solution, the characters become apparent, the muriate of cobalt afterwards attracts the humidity of the atmosphere, and they are effaced.

As to the rose-coloured or laylock oxyd, M. Thenard doubts its existence, because he was never able to obtain it by pouring a salifiable basis into a solution of pure cobalt. He thinks that the rose-coloured precipitates obtained with alkalis are no other than arseniate, or some other salt of cobalt. For the rest, "it is possible," says he, "that in these solutions the cobalt may exist in the state of rose-coloured oxyd: at the same time the contrary may be the case; and it would not be the first instance of a metallic solution having a different colour from its oxyd: highly-oxygenated nitrate of mercury is colourless, while the oxyd of that salt is red, &c."

There however exist at least four kinds of oxyd of cobalt; blue, olive, brown, and black oxyd: according to M. Thenard, the brown oxyd may possibly be a mixture of olive and black oxyd: but the want of materials prevented him from removing all his doubts, and from rendering his researches as complete as he could have wished.

wished. His investigations of the different combinations of cobalt with oxygen have, however, led to the following observations.

Desirous of purifying cobalt containing iron, he treated it with nitric acid, and poured into the solution an excess of ammoniac. After having filtered and evaporated the liquor to dryness, he treated the residue with water, and separated the fresh oxyd from it by the filtre. The water contained not only nitrate of ammoniac, but likewise cobalt: when subjected to evaporation, as it became cool, it deposited a salt, in rose-coloured crystals, of a cubic form, of a pungent taste, resembling urine, inalterable in the air, entirely decomposable by fire, emitting a lively pale yellow flame, and leaving a black residue, possessing all the properties of oxyd of cobalt; their solution yields no precipitate with any salifiable substance, but it affords one with sulphuretted hydrogen and hydro-sulphurets: potash, with the assistance of heat, disengages ammoniac, and precipitates oxyd from it. This salt is evidently an ammoniacal nitrate of cobalt.

Nickel, submitted to the same experiments, afforded the same results, with this difference, that the colour of the triple salt was green, and that the form of the crystals was not so perfect.

Oxyd of zinc, heated to ebullition with muriate of ammoniac, likewise yields a triple combination; in this case a small quantity of ammoniac is disengaged. As this salt dissolves a much greater proportion of oxyd of zinc hot than cold, a considerable part is precipitated, either as it cools or by the addition of cold water. When this solution has become cold, provided too great a quantity of decomposed muriate of ammoniac has not been employed, it gives no precipitate, either with alkalis or even alkaline carbonates: it yields a white precipitate, with

sulphuretted hydrogen and hydro-sulphurets, but does not crystallize.

In the same manner an ammoniacal muriate of lead may be obtained by treating oxyd of lead with muriate of ammoniac, or by pouring muriate of lead into muriate of ammoniac. If, to ascertain the combination, sulphuric acid be poured into the mixture, no precipitate is obtained, while alkaline carbonate produces one immediately.

Highly-oxygenated muriate of tin, which, under other circumstances, is known to be insoluble in nitric acid, when treated with this acid and ammoniac yields a solution of tin. This fact has served to explain why nitric acid, employed to act upon tin, furnishes, by evaporation, a salt containing a great quantity of oxyd: the solution is then promoted by the ammoniac produced, as M. Guyton has proved, during the action of the nitric acid upon the metal.

According to these experiments of M. Thenard, ammoniac is capable of forming triple salts with the oxyds of cobalt, nickel, zinc, lead, and tin. According to the discoveries of other French chemists, it forms magnesia and soda with the oxyds of platina, silver, copper, mercury, and with alum. Potash appears to be the alkali which has the greatest tendency next to ammoniac to produce a triple combination: and we know this is the case with the oxyds of platina, antimony, tungsten, alumine, and soda.

It therefore appears natural to conclude, from these observations, that in chemical analyses the operator should be perfectly familiar with the use of potash, and especially of ammoniac; that, to prevent falling into great errors, he ought to take the utmost care that a triple salt may not be formed, when precipitating any substance

stance from a solution with the intention of weighing it. We may likewise add, that soda not being liable, at least as far as we know, to so many of these triple combinations, ought to be preferred in many cases to the two above mentioned alkalis, as its purification is not attended with greater difficulty than that of potash, and as its carbonate may be obtained in a pure state even with greater facility. Be this as it may, M. Vauquelin has made us acquainted * with a combination of soda and phosphate of lead; it would be of utility to enter into a comparative examination of the action of this alkali upon earthy and metallic salts.

Memoir which obtained the Prize, proposed by the National Institute of France, on the Question, "To point out the Earthy Substances, and the Processes necessary for manufacturing Earthen-ware, capable of resisting sudden Transitions from Heat to Cold, and cheap enough for general Use." By M. FOURMY.

From the JOURNAL DES MINES.

(Concluded from Page 149.)

Of the Composition of common Earthen-ware.

EVERY one knows that *clay* is the substance employed for common wares. That name is given to a kind of earths, more or less ductile, to which caloric imparts a greater or less degree of solidity.

These earths are mixtures more or less complicated; the properties of which vary according to the proportions, forms, and volume of their component parts, that is, *ad*

* Journal des Mines, Messidor, year 3.

 infinitum;

infinitum; so that no two can be found in every respect alike. Those most generally employed in the composition of common wares contain alumine, silex, frequently lime, almost always oxyds or sulphur of iron; we likewise find in them magnesia, barytes, and other earths, better known in the laboratory of the chemist than in the workshop of the manufacturer; salts, animal and vegetable matters, carbon, gases, &c. &c.

Alumine and silex are, if I may so express myself, the only calculated parts; the others are seldom noticed, though their functious are not altogether indifferent. The reason of this is, that their influence is only secondary, while that of the two former is absolutely decisive. Thus setting aside the accessory substances, it may be said that the common wares are composed of an earthy mixture, whose fundamental parts are alumine and silex. The proportion is sometimes natural, but is more frequently fixed by the manufacturer, according as it suits his purposes.

These purposes must, indeed, always be subordinate to certain principles; but the application of these principles cannot be submitted to any invariable rule, because the results depend not only on the nature of the substances, or of the proportions in which they are combined, but likewise on the form and volume of the particles composing these substances, and particularly on the temperature employed.

The different kinds of baked earths manufactured at Paris are almost all composed of the same substances; yet they differ considerably both in their organisation and in their properties, because the cements which form a part of them, being more or less voluminous and abundant, modify their texture, *ad infinitum*; and because the difference between the degrees of heat employed in baking

baking them produces very great varieties in the combination of their particles.

The only general remarks that can be hazarded on the composition of the wares under consideration, may, therefore, be reduced to a very small number of general principles.

The earthy mixture employed in forming the biscuit of a ware intended to endure, *without precaution*, the alternatives of heat and cold, should unite four essential conditions; these are:

1. It should contain a sufficient quantity of alumine, and consequently be sufficiently ductile to be worked at a small expence.

2. It should contain a sufficient quantity of silex, and consequently be sufficiently soft to allow a free passage to the particles of caloric.

3. It should be sufficiently fusible to acquire the necessary degree of solidity with a moderate heat.

4. It should be sufficiently refractory to endure without alteration the heat requisite for fusing the varnish.

If too aluminous, it would acquire too close a texture, and would with difficulty be brought to take a covering.

If too silicious, it would want solidity.

If too fusible, its form would be injured by the heat necessary for the fusion of the varnish.

If too refractory, the expence of the combustible requisite for baking it would augment the price of the wares too much.

Experience alone can teach the proper medium.

Of the Composition of common Stone-ware.

Stone-wares differ from common earthen-ware in the closeness of their texture, which proceeds from the superior fineness of the clay and the violence of the heat to which they

they are exposed in baking. Their denseness varies according to the greater or less prevalence of these two causes; but it is generally such, that their fracture is smooth, like that of porcelain, and, like the silices, they strike fire with a steel: it is by this property that they are in a particular manner distinguished. In this state they cannot resist sudden transitions from heat to cold; but the farther they are from it the less capable they become of enduring those transitions, and then resemble common earthen wares so much as to be sometimes mistaken for them.

All the productions of the stone manufactories are generally called by the name of stone wares, though among the number there are some which have scarcely any more density than common earthen wares, or perhaps none at all, and which, on this account, are capable of enduring the alternatives of heat and cold; so that it is not uncommon to hear of *stone that stands the fire.*

But those acquainted with the subject confine the term of stone to a very hard kind of ware, the fracture of which bears a greater or less resemblance to that of glass, and which strikes fire with steel. Is is evident that such a substance is incapable of enduring sudden transitions from heat to cold.

It is, therefore, strictly correct to say, in general, that stone cannot stand the fire. If some of the wares, known by that name, possess this advantage, it is because they vary from the kind of manufacture to which it ought exclusively to be confined.

Stone-wares are either varnished or not varnished; some of the former (which alone we shall here notice) receive a certain varnish by means of the vapor of the muriate of soda; these belong to the class of those mentioned above, under the head of natural varnishes.

There

There are others to which artificial varnishes are applied; these varnishes are most frequently earthy, because the temperature necessary for baking the biscuit being sufficiently high for the fusion of substances purely earthy, the manufacturer can have no interest in employing either lead or salts.

Of the Composition of an Earthen-ware possessing the three Qualities which are the Object of the Question.

None of our (the French) earthen-wares at present combine these three qualities; to obtain them, we must therefore proceed in a manner different from what we have hitherto done. We shall succeed by two methods; either by forming new mixtures, or by modifying those already in use. The former would be more brilliant, without in reality possessing greater merit. The latter, being an application more easily attainable, will be so much the more advantageous. Thus, it would be useless to create; it is sufficient to improve what exists, that is, to give the compositions with which we are already acquainted the qualities they want.

Supposing we have, 1, a kind of earthen-ware capable of resisting sudden transitions from heat to cold, and at a low price, but the varnish of which contains oxyds prejudicial to health; if, without depriving it of the two qualities it possesses, we can make it take a wholesome varnish, we shall attain the desired object.

Supposing we have, 2, another kind free from unwholesome oxyds, but incapable of resisting sudden transitions from heat to cold; if without injuring the two properties it combines, we can add that which it wants, we shall likewise obtain a satisfactory solution of the question.

In

In the first case it is the varnish, and in the second the texture that must be altered. Instead, therefore, of proposing innovations that would be attended with a greater or less degree of embarrassment to those who might be desirous of manufacturing wholesome earthen-ware, I thought it more advisable to make experiments with substances already employed, and only to introduce into the usual processes such modifications as may be easily adopted in the manufactories already established.

For this purpose I took two kinds of ware, well known at Paris, each of which is in one of the cases above mentioned; the common earthen-ware of Paris being in the first, and the common stone-ware of Beauvais in the second.

Of the common Earthen-ware of Paris.

The substances proper for the manufacture of earthen-ware of a finer or coarser quality, are very abundant in the neighbourhood of Paris. The principal of these are:

No. 1, a clay of a blueish-grey colour, very fine and ductile, mixed with a great quantity of sulphur of iron. It is found at the depth of several metres below the surface of the earth; to reach it, you are obliged to penetrate through a bed of calcareous tuf, which forms the stone for building at Paris. It is dug at Arcueil, Gentilly, la Glaciére, Vaugirard, Vanvres, and Yssy.

Not only in the different pits but even in the several strata in the same pit, appear variations resulting less from the nature of its component parts than from the state and the proportions in which these parts exist; the most important of which variations consist in the more or less advanced decomposition of the sulphurs.

When purified from these sulphurs, it is proper for manufacturing not only common earthen-ware, but likewise stone-ware, of excellent quality.

A sample

A sample of this clay, taken at Vanvres, when analysed, presented,

No. 1.	Alumine	32,25	100
	Silex	63,5	
	Lime	,25	
	Iron	3,75	
	Loss	,25	

No. 2, a clay of a greenish colour, less fine and ductile than the preceding: it is found at Montmartre, Belleville, Menil Montant, &c. Almost all the hills round Paris, to the distance of several kilometres, are covered with it.

A sample of this clay from Montmartre presented the following result:

No. 2.	Alumine	19	100
	Silex	66,25	
	Lime	7,5	
	Iron	6,75	
	Loss	,5	

No. 3, a marl of a light yellow, sometimes approaching a blue-grey, and possessing almost the consistence of stone. It appears in strata of no great thickness above beds of lime-stone, and beneath the green clay above mentioned.

A sample of this marl from Menil Montant gave,

No. 3.	Alumine	8,25	100
	Silex	17,5	
	Lime	66,	
	Iron	,5	
	Evaporated Water	7,5	
	Loss	,25	

No. 4, a kind of fine sand, somewhat earthy, and of the colour of sulphur. The greatest part of it is procured at Picpus; but it is found in various other places, especially in and near Pologne.

A specimen, taken from the vicinity of Pologne, on the road which forms a prolongation of the Rue Miromenal, yielded,

No. 4.	Alumine	1,5	100
	Silex	72,5	
	Lime	24,5	
	Iron	,75	
	Loss	,75	

No. 5, a sand of a yellow ochry colour, found on the surface of the earth in the canton of Belleville, and places adjacent.

The analysis of a sample of this sand afforded,

No. 5.	Alumine	2,	100
	Silex	97,	
	Lime	,25	
	Iron	,75	

Of these five substances, the first and the last are almost the only ones employed in the composition of common earthen-ware, the others being used for other purposes, as for bricks, tiles, &c. The potters usually employ one or two parts of the clay, No. 1, to which they add one part of the sand No. 5. Their wares are in consequence extremely weak, and therefore capable of sustaining the alternatives of heat and cold, but frequently so porous that grease or liquids are absorbed, and penetrate through them.

These utensils, besides being incapable of solidity, have two other very material defects; that of communicating

a very

a very disagreeable taste and smell to victuals prepared in them, and that of being covered with a very unwholesome varnish. Both these defects proceed from the same cause, too little baking.

When earthen-ware is not sufficiently baked, several inconveniences result from it.

1. The earthy mixture composing the biscuit does not acquire sufficient solidity.

2. The fermentable substances, which this mixture invariably contains, are not perfectly destroyed or decomposed; they preserve a principle of action which they exercise upon the substances put into the vessels, and these receive more or less injury from it.

3. The saline or metallic composition forming the varnish is not completely vitrified; acids and fatty substances dissolve it more or less easily.

Complete baking alone can correct these two imperfections; and for this purpose a more powerful degree of heat is absolutely required than is usual in the potteries of Paris.

Of the Stone-wares of Beauvais.

The earths of which these stone-wares are composed are procured from various pits in a space of considerable extent from the neighbourhood of Savigny to Neufchâtel en Bray, in the department of the Lower Seine. It is used not only in the manufactories of the country, but exported to distant provinces by the name of Earth of Forges, because the canton of Forges furnishes it in the greatest quantity.

A sample of this kind of clay presented, when analysed,

No. 6.	Alumine	16,	100
	Silex	63,	
	Lime	1,	
	Iron	8,	
	Evaporated Water .	10,	
	Loss	2,	

The country abounds in various kinds of sand capable, by their mixture with these clays, of forming compositions of greater or less strength, according to the magnitude of their particles, and the proportions in which they are combined.

A sample of one of these kinds of sand, taken from a hill on the road from Savigny to St. Samson, yielded, by analysis, the following results,

No. 7.	Alumine	1,	100
	Silex	96,	
	Lime	1,5	
	Iron	,75	
	Loss	,75	

The sand and the earth, No. 6, were the materials employed for my experiments Nos. 2, 3, and 4, of which I shall presently speak.

The stone-wares made in the neighbourhood of Beauvais are principally carried to Paris; they have all the qualities, both good and bad, of the common stone-wares. In the manufactories nearest to Beauvais, that is, in the neighbourhood of Savigny, St. Sampson, &c. no varnished stone-ware is made, but only at Martin Camp, a village not far from Neufchâtel en Bray. But as the substances, processes, and productions are the same, with the exception of the varnish, all these manufactures must be ranked in the same class.

Of

Of the Alterations required by the two above-mentioned Kinds of Wares.

The great demand for Paris earthen-ware, as well as that of Savigny, leaves no room to doubt that their price is proportionably low. The former wants only a wholesome varnish, and the latter a weaker texture, to combine the three conditions which are the object of this question.

It was required to ascertain, 1, Whether, with the substances composing the biscuit of the potteries of Paris, another biscuit may be formed capable of receiving a wholesome varnish.

2. Whether the substances composing the stone-ware of the neighbourhood of Beauvais can be modified so as to form another biscuit capable of withstanding sudden transitions from heat to cold.

3. Whether the alterations necessary for producing the desired effect on these biscuits occasion a considerable or too great an increase of price.

For this purpose I prepared four kinds of biscuit, which attain the object required, each in a different manner, on account of the difference of their texture. The first is composed of three parts of Vanvres clay and one part of Belleville sand: the second of one part of Forges clay and one part of very coarse sand of St. Samson: the third of two parts of Forges clay and one part of very fine sand of St. Samson *.

Let us now proceed to examine what kinds of varnish are proper to be applied to them.

* The proportions here specified are not absolutely necessary to be employed; they are only relative to the degrees of heat, and must of course vary with them.

Of

Of earthy Varnishes suitable to common Earthen-wares.

The Chinese, whose industry in this manufacture surpasses that of European nations, make many kinds of wholesome earthen-ware. From the examination which I have been induced to make of them, I am convinced that the earthy varnishes used by them are extremely various.

The potters of Martin Camp varnish their stone-ware with an earth containing alumine, silex, lime, and iron. Those of St. Fargeau, whose stone-ware nearly resembles that of Martin Camp, employ forge-dross, which is no other than glass, likewise containing alumine, silex, lime, and iron.

I have more than one reason for believing that the substances employed by the Chinese are not of the most fusible nature; on this subject, however, I am confined to presumption, while, on the other hand, I know that the substances used at St. Fargeau and Martin Camp require a very elevated temperature.

I conceived that a composition less refractory, and consequently less expensive, with regard to the baking, would be preferable if the wares would not be injured by this economy. This idea led me to a long and expensive investigation of the different substances that appeared likely to fulfil the object in view, that is, to furnish, at a low price, a solid varnish, capable of resisting acids, and impenetrable by greasy substances and liquids.

The limits of this memoir will not admit of my entering into a detail of the experiments which I made, with this view, on the numerous substances offered, more or less gratuitously, by the territory of the republic. I shall therefore confine myself to stating, that I found nothing more suitable than volcanic productions. Among these the

the pumice-stone appeared to deserve the preference, on account of its superior fusibility; but certain kinds of lava very nearly resemble it.

It would be unnecessary to give the analysis of pumice-stones, both because they are so well known, and because the composition of every kind is not the same. All however contain, in greater or less quantity, alumine, silex, lime, and a small quantity of iron, sometimes a very small proportion of magnesia, and other earths.

But whether the kind of vitrification which these mixtures have undergone in the volcanoes has brought them to the same degree of fusibility, or whether it proceeds from some other cause, the differences which appear by their analysis, either in their component principles or in the proportions of those principles, have presented no variations of importance in the results.

I therefore conceive that volcanic productions are perfectly suitable for varnishing wholesome earthen-ware at the cheapest possible rate. Of all the compositions of a purely earthy nature that I have tried, none has produced such a complete fusion at a temperature equally low.

Of the Effect which the proposed Modifications would produce upon the Price.

All the heads of expense incurred in the manufacture of earthen-ware may be reduced to five principal ones.

1. The substances composing the paste or biscuit.
2. The preparation required by those substances to dispose them to receive the moulds.
3. The labour of moulding.
4. The substances of which the varnish is composed.
5. The baking.

Of

Of these, the three first experience, from the proposed modifications, no alteration that can affect the price: the two latter only are capable of producing any variation in the expense.

If we first take, as a medium of comparison, the common earthen-ware of Paris, we shall see that by the new method the heat must be more violent, which would consequently increase the expense in the article of fuel. But we shall likewise find that this increase is counter-balanced by an important diminution in the price of the varnish.

The potters of Paris employ as a flux red oxyd of lead, commonly called *minium*, with which they combine Belleville sand and Vanvres clay; these form a varnish, which stands them in about 60 centimes, *per* kilogramme (somewhat under 3 *d. per* lb.) The refuse of pumice-stone, or that which, being too small for the ordinary operations of polishing, is held in low estimation in commerce, is worth at Paris from 30 to 50 c. the kilogramme, or, upon an average 40 c. that is, two-thirds of the price of the varnish used by the potters. This difference arises from the facility of pounding the pumice-stone, the expense of which is very trifling.

But what in an extraordinary degree increases the advantages possessed by this substance is, that being very light, less in quantity by almost one-half is required than of the common varnish: so that, taking every circumstance into the calculation, the varnish which it furnishes costs less by above one-third than that now employed.

Thus this diminution over-balances the increase caused by the elevation of the temperature, and it is incontestible that the proposed alterations will produce a diminution in the expense attending the manufacture of the

common

common earthen-ware of Paris. With regard to that made in the neighbourhood of Beauvais, either the employment of the common varnish may be continued, or the pumice-stone may be substituted in its stead. In the first case, the change, as it has been observed above, will be confined to the texture, and cannot affect the price.

In the second case, if on the one hand pumice-stone be dearer than the substances at present employed, as it may happen in certain places; on the other hand it affords the means of abating the temperature, and consequently of diminishing the expense of fuel; if on the contrary it be no dearer, as must be the case in many parts, the diminution resulting from a lower temperature will be clear profit.

Thus taking the subject in the least favourable point of view we have an equality in the expense; but, on the contrary, there is every reason to promise a considerable diminution. In either case it is certain that no other method combines so many advantages.

The Institute will observe that the fruits of the experiments here presented are not the result of a regular system, in which foresights and errors have been corrected; they ought not therefore to be examined with the same strictness as the produce of an established manufacture. Their merit does not consist in the execution, but in the just and enlarged principles upon which they are composed.

I have not merely confined myself to the indication of a receipt capable of fulfilling the three conditions of the question. It was my desire to prove, that with the substances employed in the composition either of the common wares of Paris, or the stone-wares of Beauvais,

 other

other biscuits may be obtained that will resist sudden transitions from heat to cold, and capable of receiving wholesome varnishes.

My attempts leave no uncertainty on this point; the question is therefore resolved as far as regards the biscuits; but the results which I have obtained, and all those which may be obtained, with the substances employed at Paris, and in the neighbourhood of Beauvais, may be produced with all the substances of a similar nature contained in abundance within the territory of the republic. What I have said concerning biscuits is therefore applicable to all the manufactures of earthen-ware in France.

With regard to salubrious varnishes, it is possible there may be circumstances and local situations in which other mixtures, either natural or artificial, would be found more suitable than that which I employed. In places, for example, where fuel is very cheap, it might be advantageous to augment the heat, that the manufacturer may be enabled to use more refractory but less expensive substances than pumice-stone.

I do not pretend to confine the potter invariably to one substance; I only maintain the principle which induced me to select the material in question for the manufactures of Paris, and propose it as an example to which the workman may conform, or from which he may depart at pleasure, according to circumstances, equally impossible to be stated and foreseen.

The essential point is to obtain, at the lowest possible rate, a salubrious varnish, the employment of which is not incompatible with the qualities required in the biscuit. As pumice-stone best answers this purpose in the manufactures of Paris, I have given it the preference; but

but this is no reason for adopting it in places where other substances afford superior advantages. Each manufacturer must employ whatever is most suitable; but the question is nevertheless resolved with regard to the varnish. It has been shewn above, that it was likewise answered with regard to the price. It is therefore resolved as to the three subjects contained in the question.

Conclusion.

The contents of this memoir may be compressed into the following statements:

1. If either the earthy substances employed at Paris, and in the neighbourhood of Beauvais, or others of the same nature, be combined, the manufacturer will obtain biscuits of earthen-ware capable of resisting sudden transitions from cold to heat.

2. Volcanic productions, and especially pumice-stone, will furnish for these biscuits a cheap, solid, and perfectly salubrious varnish.

3. The fusion of this varnish being more easy than that of other earthy varnishes, is accompanied with less expense in baking than the earthy varnishes now in use, and yet the temperature it requires is sufficient for giving the biscuit the necessary solidity, and for purifying it from those substances which, in wares exposed to a low degree of heat, produce a disagreeable taste and smell that cause them to be disliked.

This solution not only far exceeds the limits of the question, but likewise presents two important advantages: in the first place, it is applicable to all manufactories that are or may be established; and, in the second, the improvement may be immediately executed.

 Thus

Thus whenever we please we may banish from all our manufactories the erroneous processes which operate to the detriment of their productions, and with substances derived entirely from the soil of the republic, we may make earthen-ware at the same price, or even cheaper than that now made, which will give neither a disagreeable taste nor smell to victuals, which will be solid and salubrious, and will resist sudden transitions from heat to cold.

Description of a portable Thermometer, adapted to ascertain the Temperature of Wine-Vats, and Dyeing-Coppers, and capable of being applied to various other Uses.

From the ANNALES DES ARTS.

WE are indebted to M. Regnier for the invention of several kinds of metallic thermometers, the advantages of which are already acknowledged; he has likewise turned to account the extreme sensibility with which copper indicates the alterations of temperature. These thermometers are of different forms; that in general preferred is a tube of the above metal, into the inside of which is introduced a curved piece of iron or steel, the two ends of which are soldered, or otherwise attached to the extremity of the tube; a pinion, combined with this piece of metal, turns an index on the outside of the tube, the hand of which moves upon a portion of a graduated circle, for the purpose of indicating the contraction or expansion of the thermometer by cold or heat.

M. Regnier, by devoting his attention to the construction of a thermometer adapted to the operations of making

wine, contrived a portable thermometer, which he has presented to the Lyceum of Arts.

The tube and graduation of this instrument are the same as in the common thermometers; the mounting only exhibits a new arrangement proper for rendering it serviceable in agriculture and the arts.

The cane containing this thermometer is in the whole about a metre (three feet four inches) in length. The socket of this cane is of copper: it forms a long ferrule, which preserves the glass cylinder containing the liquid of the thermometer. The socket is pierced with several small holes, through which the fluid enters when the end of the cane is plunged into it, of course the liquor of the thermometer immediately receives the impression of the caloric, an advantage that is not possessed by the common thermometers for liquids, which are always too slow in their progress.

The iron end of the cane which rests upon the ground is supported at the extremity of the socket by a spring that yields when the end of the cane rests upon hard substances; and by this contrivance the thermometer is equally preserved from shocks on every kind of ground.

Another spring, placed immediately over the ball of the thermometer, yields when too much weight is borne upon the cane on a pavement, so that the prejudicial effects of every kind of shock or pressure are completely prevented by the disposition of the two springs.

The upper part of this cane is terminated by a ball of cork, covered with Morocco leather; the elasticity of the cork keeps the thermometer from breaking if the cane be accidentally dropped; but for the greater security a ribbon or string, to lay hold of, may be added.

In the centre of this cane a cavity is made, in which the tube of the thermometer is fixed, and half of its circumference,

cumference, towards the top, opens with a hinge, for the purpose of making observations when the liquid of the tube is seen, and the scale graduated upon the ordinary principles.

This opening shuts by means of two small hooks fixed in the wood; the thermometer then exhibits the appearance of a cane neatly varnished.

This new contrivance renders the thermometer extremely useful.

1. To ascertain and to compare at a certain depth the temperature of sown land, when the surface is hard frozen.

2. To estimate the heat of hay-stacks which sometimes take fire before the farmer is aware.

3. To compare the heat of garden-beds.

4. To find out the state of fermenting liquors: this thermometer will be the more useful for this purpose, as glass instruments sometimes employed for such observations are liable to break.

5. In the arts, for every kind of operation in which the heat of coppers is regulated to a certain degree.

Independent of objects of utility, this thermometer is an agreeable companion to the observer who, in his country-walks, wishes to ascertain and compare the temperature of different springs and streams, or any other similar purpose; and the convenience of being able to thrust it into various substances without breaking must be considered an additional recommendation.

On

On the Art of hardening Copper.

From the ANNALES DES ARTS.

COPPER in a state of purity and perfection is soft and malleable; its tenacity is so great as to equal that of gold or iron. If copper be hammered cold for a long time, or more especially when it is flatted, it is found to acquire a still greater degree of hardness, but yet it is not capable of resisting violent pressure. If copper be made red-hot and suddenly plunged into water, instead of becoming hard it is rendered more flexible, and consequently softer than before. If copper be kept a long time in fusion, or be frequently melted by a brisk fire, without being covered with a flux or pulverized charcoal, it becomes brittle, unmalleable, and of course harder. But these qualities are corrected when copper is melted in contact with some carbonaceous substance. If melted copper be poured in water, as for the purpose of granulation, it is not, like steel, rendered harder by this operation.

If we reflect on all these facts proved by numerous experiments, we cannot but be astonished at the process employed by the ancients for hardening copper, of which most of their warlike instruments were made; though those implements of death are frequently mentioned by different writers, yet none of them has transmitted to us their method of hardening that metal. We have therefore been confined to conjectures on that subject; it has been conceived that copper could be hardened in the same manner as iron, and the same processes have, therefore, been employed. Their result, however, has only proved the ignorance of the operators of the principles of chemistry.

Thus

Thus the art of hardening copper has been reckoned among those that were known to our ancestors, but are now lost; but various circumstances and particularly researches made in ancient monuments have brought to light various articles, the composition of which has been investigated by analysis. This has shewn that the hardness of copper proceeded by no means from any introduction of charcoal into the mass, but from the mixture of another metal, which by its combination with the copper, augmented its hardness.

Mongez found that the composition of the pieces examined by him very much resembled that of bell-metal; he transmitted to Dizé a fragment of a copper dagger, the fracture of which proved that it was cast and not hammered. A solution of this instrument in nitric acid furnished a white precipitate, which was oxyd of tin; the copper was dissolved: this first experiment proved that the whole art of the ancients consisted in producing a combination of some other metal with the copper. The subsequent experiments of Dizé on Greek, Roman, and Gallic coins confirm this fact, the tin being found in these in the proportion of 24 *per cent.*

M. Hjelm, a Swedish gentleman, has lately turned his attention to this subject. He received of Professor Retzlis, of Lund, a piece of a two-edged dagger, which, together with some stone-cutter's chisels, was found in Sweden, where sabres perfectly entire are often discovered. This fragment was, externally, of a yellowish colour like brass; the edge was blunt; the fracture was granulated, and proved that the instrument had been cast: when tried with a file, this metal seemed by no means so hard as bell-metal, but harder than the brass employed for cannon. The surface of the part submitted to the file was of an orange-red colour, which soon turned to yellow,

yellow, when tried with the blow-pipe, it exhibited no appearance of zinc, but it was easy to perceive that copper formed the principal part of the composition. The filings being exposed to the action of the loadstone were not affected; and as far as could be judged from the vapour disengaged from it when submitted to the blow-pipe, it contained a very small quantity of any other metal.

To discover with what metal the copper was combined, M. Hjelm took twenty-five pounds of the purest filings of the above-mentioned fragment; he heated some nitric acid, diluted with a small quantity of distilled water in a glass retort, and put into it a portion of the filings. When the first quantity was dissolved, the remainder was added by degrees till the dissolution of the whole. He then boiled the solution for a quarter of an hour, and diluted it with a little more distilled water to facilitate the precipitation of a white powder. The blue liquor containing only a solution of copper was decanted, the white precipitate was diluted with distilled water, and afterwards filtered. The powder that remained, on the filtre being dried and weighed, yielded $5\frac{3}{8}$ pounds, or 21 in 100 of oxyd of tin. As this oxyd, upon reduction, loses nearly one-fourth of its weight, these $21\frac{1}{2}$ pounds of oxyd must afford $16\frac{1}{3}$ of tin in a metallic state; this fact has been proved by experiment, and the regulus obtained was perfectly pure. Thus the dagger was composed of $83\frac{5}{8}$ of copper, and $16\frac{1}{3}$ of tin, or, rejecting the fraction, of 84 parts of copper and 16 of tin.

In order to ascertain by experiment the accuracy of this analysis; the blade of a knife was made with the same proportions; it was polished and set in the usual manner. This blade had all the properties and the external appearance of the fragment of the dagger, but

 lost

lost its edge very soon. Another was made with 20 parts of tin, and 80 of copper; the latter was whiter, harder, and more brittle; it broke during the polishing, and was notched with merely cutting a pen.

The degree of brittleness is increased when the proportion of tin is augmented to 25 *per cent.*; the copper-colour disappears, and the mixture becomes white. The same qualities are heightened when the proportion of tin is raised to 30 *per cent.*; which forms an excellent composition for making looking-glasses, spectacles, or telescopes. It is well known that in general the brass for cannon contains 9 *per cent.* and sometimes a greater quantity of alloy more than common brass; it being in the proportion of 16 to 100; for this purpose too, a considerable quantity of zinc is commonly used instead of lead.

What has already been stated is sufficient to confirm the opinion, that the instruments of the Ancients were no other than an alloy. Monnet has supposed that they added arsenic to the copper, but till we find that substance in some fragment that opinion may justly be doubted. Dizé, speaking of the addition of iron to copper with a view to harden it, endeavours to prove that Geoffroy had not maturely considered the subject when he asserted that such a mixture produced a metal as hard as the copper of the Ancients.

If we, however, consider the manner in which Count Caylus relates the experiment, the result is different. Geoffroy undertook these experiments to satisfy the Count, who had observed that the filings of several ancient instruments which he had examined were subject to the attraction of the loadstone. It is certainly extraordinary that at such a remote period the art of combining

copper

copper with iron, a process now considered extremely difficult, should be so well known.

Mineralogists know that the ordinary copper ores contain copper and iron, mineralized by sulphur, which are commonly termed cuperose pyrites; not because copper constitutes the greatest part of them, but because that metal is the most valuable: on the contrary, the principal portion appears to be iron. When this ore is melted, the first copper obtained from it is more or less pure, according to the quantity of iron contained in it, or the greater or less degree of care bestowed upon separating it during the operation. Thus copper may not only be obtained in combination with any quantity of iron that may be thought proper, but all kinds of instruments may be cast with it; these may afterwards be hammered when cold, and after all be submitted to the process of hardening, like pure steel. According to M. Hjelm this method has been tried with complete success.

Without endeavouring to diminish the force of this assertion, which appears extremely probable, we wish that experiments may be made on such a metal, which may easily be procured in the neighbourhood of copper mines. It would be difficult to enumerate all the advantages that would be derived from it for the making of scales, hardware, flatting-machines, cylinders for paper-mills, &c. Perhaps even upon a trial of this substance it might be found a valuable material for artillery; at least if this mixture possess the tenacity of the two metals, we might be enabled to diminish the weight of our cannon without lessening their strength; and we should likewise be relieved from all apprehensions of their bursting, which accident so frequently occurs with alloys of brass.

If we refer to periods of remote antiquity, we shall find that metallurgy was far from being so well under-

stood as in modern times. The use of bronze was very early introduced into the arts; the ornaments of warlike instruments are more easily formed of that metal than of iron; and indeed almost all the fragments of arms discovered at the present day prove to be alloys that differ only in the greater or less proportion of tin added to the copper; and though the discovery of the art of making steel has occasioned the disuse of brass instruments, it is not the less true that this metal and its alloys are still capable of furnishing important resources.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Highland and Agricultural Society of Scotland.

ON the 10th of January this Society held their anniversary general meeting, which was attended uy upwards of one hundred noblemen and gentlemen. Having taken into consideration the business which had come before the committee of directors since the last meeting, the members highly approved of their attention to the objects of the institution, which appeared from a number of premiums adjudged to authors of essays of merit on subjects connected with the improvement of agriculture and the fisheries, by which much useful information had been obtained. The Society likewise approved of the premiums voted for the improvement of waste lands, raising green crops, meliorating the breed of black cattle, curing the diseases incident to sheep, and for exciting emulation among ploughmen. As a considerable increase was found to have

have taken place in the funds of the Society, a larger sum than usual was voted to be laid out in premiums towards the encouragement of useful objects during the present year.

The utility of an investigation and enquiry into the comparative quality of English and Scots barley, and of bigg compared with barley, for the purpose of being made into malt, being suggested, the society referred to the directors to take the necessary measures for obtaining such information.

Sir John Sinclair presented a memorial on the general advantage to the country of opening a speedy communication, by a diligence or mail-coach, from Perth by the Highland Road to Inverness, and of course to the northern counties of Ross, Sutherland, and Caithness, which, upon the motion of that gentleman, was likewise referred to the committee of directors.

The secretary reported that the second volume of the Society's Transactions had been published since the last anniversary, and was received with much approbation, as containing important information, and experiments on various subjects, connected with the objects of the institution.

It was also mentioned by the secretary, that reports had been made by some of the members on the success of the Egyptian barley and Ruta Baga, presented to the Society by Mr. Benjamin Bell, and distributed in very small parcels, for experiments; and particularly that a very distinct and accurate report had been received from Lord Balmuto, by which it appears that the Egyptian barley, if proper attention be paid to the cultivation, is likely to prove a valuable acquisition.

Description

Description of a Mechanical Pulley.

The French Minister of the Interior having requested the opinion of the Class of Mathematical and Physical Sciences of the National Institute, on the various machines of M. Fyot, formerly Professor of Mathematics; Messrs. Bossut and Leroy were appointed to examine the inventions of that mechanic, who has spent the greatest part of his long life in contriving new machines that might be serviceable to society.

Among these machines, that which most attracted the notice of the deputies was his mechanical pulley. This is an ingenious contrivance, and deserves to be described. It is so constructed that a weight may be raised without running any risk of the cord slipping, or the pulley turning round, so that it remains suspended without danger.

The body, properly speaking, of this mechanical pulley is a cylinder, of the diameter that would have been given to the groove, and the same thickness as a common pulley. This cylinder is fixed into an arm, which has two pivots. To each side of this arm is fastened a small piece of wood, of sufficient diameter to form, above the cylinder just mentioned, a narrow passage, the sides of which are of such a height as to contain properly the cord that is intended to run through it. These two pieces project on the side opposite to that on which they touch the cylinder, and are of a suitable thickness. They have grooves, which begin at a certain distance from the centre, and proceed to the circumference; and on their inner surface they are made rough, that they may the better hold the cord. A kind of fork, moveable on pivots, is continually pressed by a spring against the two pieces of wood, so that each of its teeth enters the grooves made in them. If this be clearly understood it is easy to conceive

conceive that when the cord is pulled in the usual way the fork is no obstacle to the motion of the pulley; but the moment it is loosed, the fork, pressing, by the effect of the spring, against the projecting pieces of the wood, by these means hold the cord tight in this artificial passage, and prevents it from slipping, while the pulley itself is stopped by the teeth of the fork that fix themselves into the grooves. There is a lever which serves upon occasion to remove the springs, and prevent their action.

Meteorology.

The following is an account of the depth of rain fallen in Liverpool in the last six months of 1803, and the evaporation of water out of a vessel four inches diameter, placed out of the reach of the solar rays, or influence of fire. Continued from vol. III. page 238.

	Fall of Rain.	Evaporation of Water, &c.
	Inches.	Inches.
Total during the first Six Months . . .	11,73	11,91
July	1,54	3,
August	1,88	2,88
September	1,60	2,55
October	,82	1,55
November	3,25	1,10
December	4,60	1,
Total . . .	25,42	23,69

List

List of Patents for Inventions, &c.

(Continued from Page 160.)

JAMES STURMAN SEARLES, of Little Alie-street, Goodman's-fields, in the parish of St. Mary, Whitechapel, in the county of Middlesex, Gun-maker; for an improvement or improvements to be applied to any kind of fire-arms or defensive instruments.
Dated December 3, 1803.

CHARLES WYATT, of New Bridge-street, in the city of London, Merchant; for a new-invented process of purifying ardent spirits.
Dated December 21, 1803.

ROBERT CROSS, of Quakers Brook within Houghton, in the county of Lancaster, Tanner, and THOMAS SOUTHWORTH, of Houghton, aforesaid, Cotton-manufacturer; for their new-invented mode of heating such pans, vats, cisterns, and other vessels, as are required to be heated by fire, and used for working steam-engines, and in the businesses of calico-printer, dyer, brewer, paper-maker, bleacher, salt-maker, tanner, and other such like trades; by which invention much expense will be saved, not only in the fuel to be used in the heating of such vessels, but also in constructing the vessels themselves.
Dated December 31, 1803.

ERRATA.

In page 81, line 6, *for* 1803 *read* 1793.
126, 4, *for* safflower *read* zaffre.
135, 15, *for* lobes *read* receivers.